FOUNDRY TRADE JOURNAL

EST. 1902

WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

VOL. 107
No. 2230
Registered at the G.P.O. as a Newspaper

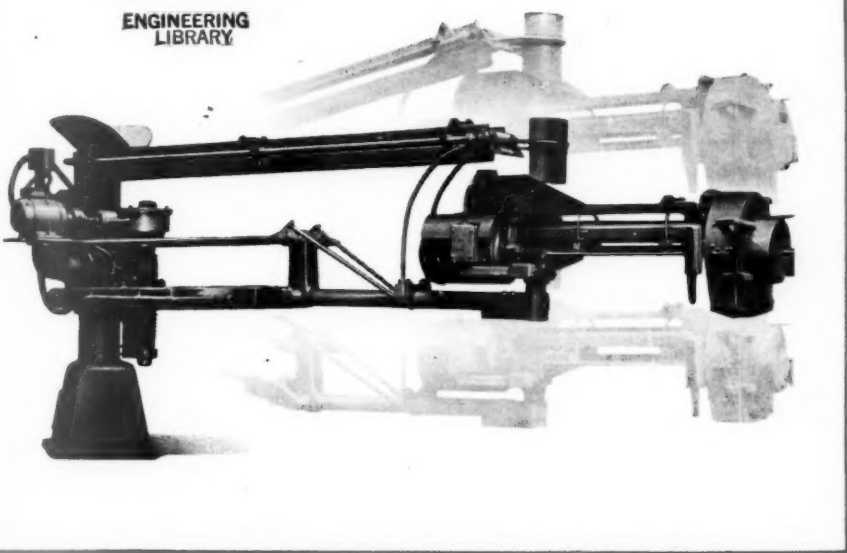
SEPTEMBER 3, 1959
Offices: John Adam House, John Adam St., London, W.C.2

Single Copy, 1/-. By Post 1/4. Annual Subscription, Home 52/-, Abroad 60/- (Prepaid)

THE UNIVERSITY OF MICHIGAN

SEP 28 1959

ENGINEERING LIBRARY



STATIONARY TYPE SANDSLINGER
with arm raising and lowering gear

Sandslinger

Foundry Plant & Machinery Ltd

EGLINGTON WORKS
COOK STREET
GLASGOW, C.5

BIGGER VALUE

AND MORE COMPACT DIMENSIONS IN THE IMPROVED

LH-1 Loader

Numerous improvements now incorporated as standard, add up to better value than ever in the Muir-Hill LH-1 diesel hydraulic loader. Used in countless jobs in works, factories, and ships' holds, users say they don't know how they managed without it.

If you have a bulk material handling problem in a confined space, it could mean the same to you.

LET US SEND YOU THE LITERATURE.

dm E8858

Muir-Hill Regd.

BUILT BY BOYDELL

E. BOYDELL & CO. LTD · UNIVERSAL WORKS · OLD TRAFFORD · MANCHESTER 16

FOUNDRY TRADE JOURNAL

Vol. 107. September 3, 1959 No. 2230

Established 1902

Incorporating

IRON & STEEL TRADES JOURNAL

Single copy 1s.; *by post* 1s. 4d. *Annual subscription: home* 52s., *abroad* 60s. (*prepaid*)

Editor:
V. C. FAULKNER. F.R.S.A., HON.M.I.B.F.

Assistant Editor: A. R. PARKES, M.I.B.F.
Commercial Editor: P. E. CARDEN

Advertising Manager:
F. BARRINGTON HOOPER, B.A.

Production Manager:
R. J. LOVELL

Publisher: H. J. DWYER
Circulation Manager: E. T. GRIFFITHS

District Representatives:
G. P. ELLIOTT (Northern Area)
T. H. SMITH (Scotland)
D. C. RYALL (Southern Area)

The FOUNDRY TRADE JOURNAL is the official organ of the British Steel Founders' Association; Association of Bronze & Brass Founders; the Light Metal Founders Association; Foundry Trades' Equipment & Supplies Association; and the National Society of Master Patternmakers.

AN INDUSTRIAL NEWSPAPERS PUBLICATION

Published Every Thursday by Industrial Newspapers, Limited

BARRINGTON HOOPER, C.B.E.
Chairman and Joint Managing Director

F. BARRINGTON HOOPER, B.A.
Joint Managing Director and Commercial Director

F. R. LEWIS, JOHN HOOPER, D. HORN
Directors

E. G. WESTON,
Director and Secretary

JOHN ADAM HOUSE,
17-19, JOHN ADAM STREET,
ADELPHI, LONDON, W.C.2

Telephone: Trafalgar 6171 (Private Branch Exchange)

Telegraphic Address: "Zacatecas, Rand, London."

PRINCIPAL CONTENTS

PAGE

Durgapur Steel Works

Description of the foundry at the new steelworks which is being constructed at Durgapur, India 101

Costing of Patterns

By John L. Carter

Useful hints on the correct apportioning of charges and costs for patternwork are given and the importance of close cost-control is emphasized 104

European Investment Casters' Conference

Survey of the proceedings at the sixth European conference of investment founders held in Essen earlier this year 107

Silica Binders for Investment Casting

By J. I. Evans, M.Sc., A.R.I.C.

Outline of the chemical background of the silica binders used in investment casting. Suggestions are made for close control of the various processes 113

Prototypes from Polystyrene Patterns 122

Aciéres de Durgapur.
Description de la fonderie des nouvelles aciéres qui sont en cours de construction à Durgapur, aux Indes. 101

Prix de Revient des Modéles. Par John L. Carter.
Des conseils pratiques sur la répartition correcte des charges et des frais de confection de modéles sont donnés, et l'importance d'un contrôle sévère du prix de revient est soulignée 104

Conférence Européenne des Fondeurs à la Cire perdue.
Examen du procès-verbal de la sixième conférence Européenne des fondeurs à la cire perdue, tenue à Essen au début de l'année. 107

Liants à la Silice pour le Moulage à la Cire perdue. Par J. I. Evans, M.Sc., A.R.I.C.
Aperçu de la composition chimique des liants à la silice utilisés pour le moulage à la cire perdue. Des suggestions sont faites pour un contrôle étroit des différents procédés. 113

Durgapur-Stahlwerke.
Beschreibung der Giesserei in dem neuen, in Bau begriffenen indischen Stahlwerk Durgapur 101

Kostenberechnung von Modellen. Von John L. Carter.
Es werden nützliche Hinweise bezüglich richtiger Aufteiling von Lasten und Kosten für Modellarbeiten gegeben und es wird auf die Bedeutung einer genauen Selbatkostenüberwachung hingewiesen 104

Tagung der Europäischen Feingiesser.
Überblick über die Verhandlungen auf der 6-europäischen Feingiessertagung, welche zu Beginn dieses Jahres in Essen abgehalten wurde. 107

Kieselerdehältige Bindemittel für Feinguss. Von J. I. Evans, M.Sc., A.R.I.C.
Eine kurze Übersicht über die chemische Zusammensetzung von Bindemitteln auf Kieselerdebasis, welche für im Wachsausschmelzverfahren herzustellende Abgüsse verwendet werden. Es werden Vorschläge zwecks genauer Kontrolle der verschiedenen Verfahren gemacht. 113

Features, News, Commercial Information and Statistics

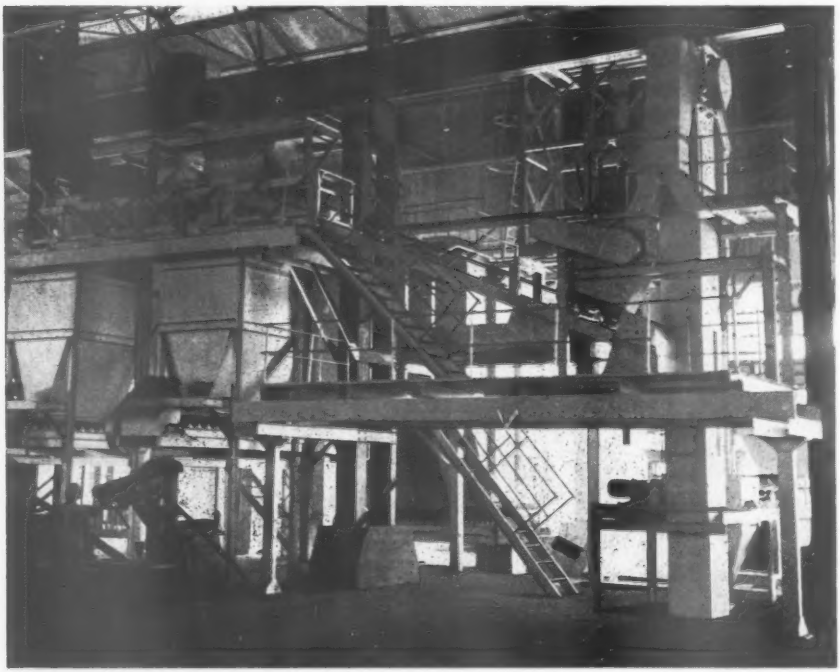
Leader: Quality Labels 99
I.B.F. National Works Visits Day 100
Early Methods of Quality Control 103
Cupola Botting Materials 105
Equipment and Supplies 106
National Foundry Apprentices Competition and British and World Shipbuilding 123
Personal 124
News in Brief 125
Raw Material Markets 127
Current Prices of Iron, Steel and Non-ferrous Metals 128
American Letter 130
Farnborough Exhibition 131
Company News 132
Book Review and Publications Received 134
Pig-iron and Steel Production 136

August's LIMITED

Mechanised Foundry Plant in modern INDIA

SAND
RECONDITIONING
MIXING
DISTRIBUTING

Photograph shows plant for conveying return sand into the bucket of a loader prior to charging an August-Simpson Mix-Muller. The mixed sand is then elevated, aerated, conveyed and distributed to large moulders' supply hoppers fitted with belt feeders. A cooling tower, also incorporated in this plant, ensures the efficient cooling of the return sand.



Photograph published by kind permission of The Indian Iron & Steel Co., Ltd., New Steel Foundry, KULTI.

Sole Licensees and Manufacturers for the British Empire (excluding Canada, Australia and New Zealand) of the Simpson Sand Mixer.

AUGUST'S LIMITED · HALIFAX · ENGLAND

Telephone : Halifax 61245/6/7/8 Telegrams : August, Halifax.

J.J.M

FOUNDRY
TRADE JOURNAL

Vol. 107 SEPTEMBER 3, 1959 No. 2230

Quality Labels

At a recent meeting of the European Committee of Foundry Associations it was proposed that quality labels for castings should be introduced into each country and then, after that, an international quality label should be established. This word " label," of French origin, has much the same significance as the " Kite " mark sponsored by the British Standards Institution. The range of foundry raw materials and finished products now carrying a label in France is indeed extensive, and unlike our system—with the unique title of " Kite "—each product is separately trade-marked. For instance, in the case of foundry blackings (*noirs de fonderie*) the name chosen is *Noirfran*. Two types are marketed in France, " mineral " and " stove " and the specifications covering their properties lay down for the first type the ash and volatile contents for three grades and for the second type, the volatile matter and carbon contents—also for three grades. Permission to use the label *Noirfran* is accorded to firms which guarantee conformity with the specification and which are registered on the official list of suppliers.

The products of some—if not all—types of French foundries are similarly trade-marked. For instance, so far, 58 ironfounders have been granted permission to use the label *Fontfranc*. The conditions for its use have been intelligently assessed and include the compiling of strict working records, using good working-methods, keeping well-organized stockyards, regularly employing cupola air-blast control, and the continuous use of the pyrometer. Dimensioned sketches as to how castings are gated also have to be kept.

This is a very important development, for, obviously, firms which have been granted permission to use these labels will use the fact as a basis for publicity. The scheme must also act as a spur to those who are at the moment insufficiently-well organized to comply with the conditions. So far as British iron foundries are concerned, we would estimate that between 200 and 250 are worthy of being accepted. If in the future there is to be a serious international market for castings, then the sooner this country emulates the French scheme, the better.

IBF National Works Visits Day

For the tenth year in succession, the Institute of British Foundrymen is to hold a National Works Visits Day, and this year the London branch has made the necessary arrangements. These works visits supplement the arrangements already made by branches and those afforded at the annual conference, and in particular enable those members who cannot spare the time to attend the whole of a conference to take part in an annual national gathering.

Programme

The visits, which have been made possible by the kind agreement of a number of important founders in the London area to receive parties and to provide hospitality, will take place on Friday, October 30. Since travel in and out of central London is time-consuming and the foundries are well scattered, more whole-day visits than usual are included in the programme. Thus, of the six visits, four will be whole-day visits to single foundries; the other two will consist of a visit in the morning and a visit in the afternoon. Luncheon will be provided at a suitable place at mid-day. The schedule of visits is recorded in Table 1.

Members are asked to indicate on a reply form which of the visits they prefer to attend and—as the number permitted in each party is strictly limited—their second and third choices. Coaches will leave from the Thames Embankment (north side of the river, between the end of Horse Guards Avenue and Charing Cross *Underground* Station) at the following times:—For visit "A," 8.45 a.m.; "B," 9 a.m.; "C," 9.15 a.m.; "D" and "E," 9.30 a.m.; and "F," 9.45 a.m.

Dinner

In the evening, there will be a dinner (informal dress) and entertainment at Lyons' Corner House, Tottenham Court Road (opposite the Dominion cinema theatre). The charge for each group of visits including transport by coach, luncheon, gratuities and administrative expenses is 21s., and the additional charge for dinner in the evening at the Corner House is 22s. 6d. Members who desire to participate are requested to return a reply form to the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3, not later than Wednesday, September 30, or earlier if possible.

Those participating are required to make their own arrangements for hotel accommodation, and are advised to book at the earliest possible moment, and in any case not later than September 30—especially as the date of the visits is within the period of the Motor Show. As the choice of hotels in London is so wide, no block reservations or special terms are available to members.

Table I—*Works to be visited in the London Area by kind invitation of Directors and Managers of Each Company.*

Party.	Morning visit.	Luncheon and tea.	Afternoon visit.
A	Ford Motor Company, Limited, Thames Foundry (automobile and tractor castings production in highly mechanized foundry).	Ford Motor Company, Limited	Ford Motor Company, Limited, Dagenham Works (motor-car and tractor production).
B	K. & L. Steelfounders & Engineers, Limited (steelfoundry with special interest in steam, electric and diesel-loco work, long and medium production runs).	K. & L. Steelfounders & Engineers, Limited.	K. & L. Steelfounders & Engineers, Limited (if time permits, this company's facilities for machining castings and assembling cranes will also be inspected).
C	Langley Alloys, Limited (copper-base, nickel-alloy and aluminium castings by a variety of methods).	Luncheon: Langley Alloys Limited; tea: G. D. Peters & Company, Limited	G. D. Peters & Company, Limited (iron castings on both mechanized (to 4 cwt.) and batch production basis to 16 cwt.).
D	British Bath Company, Limited (mechanized bath manufacture and enamelling).	Luncheon: British Bath Company, Limited; tea: Le Grand Western Foundries, Limited.	Le Grand Western Foundries, Limited (jobbing and medium-run iron castings up to 3 tons; CO_2 process).
E	Broom & Wade, Limited (general engineering iron castings up to approximately 2 tons).	Broom & Wade, Limited. ..	Broom & Wade, Limited (continue tour of foundry, compressor and small-tool manufacturing shops).
F	R. & A. Main, Limited (speciality mechanized stove foundry (iron)).	R. & A. Main, Limited	R. & A. Main, Limited (cooker assembly and fitting shops; vitreous enamelling).

Information on Boiler Materials

The British Standards Institution has made a request for information on boiler materials. According to a statement in the BSI *News Sheet*, "Progress in the metallurgical field is leading to the use of new materials for the construction of domestic hot-water boilers and the BSI technical committee concerned with domestic-solid-fuel appliances has given consideration to the establishment of British standards covering the use of these new materials. A certain amount of information has been collected but, undoubtedly, there is a great deal more which is not yet available to the committee. An invitation is, therefore, extended to firms and organizations which have assembled the results of experience in this field to submit such data for consideration by the technical committee as soon as possible. Letters should be addressed to Mr. J. O. Lay, secretary, technical committee, SFE/13, British Standards Institution, 2, Park Street, London, W.1."

Forty Years Ago

The September 1919 issue of the JOURNAL carried an article by Mr. E. H. Broughall on the "Practical Use of Denseners and Permanent Moulds." At that time Mr. Broughall was foundry manager at Alfred Herbert, Limited, and in his excellent report he described the making at the company's foundry of a hexagonal turret in a permanent mould. This issue also carried radiographs of steel castings—probably the first ever to be published on this subject. Amongst new companies listed appeared the names of Davis & Brocklesby, Limited; Rustless Iron Company, Limited; and Millom and Askham Hematite Iron Company, Limited.

A NEW company, George Cohen (Dublin), Limited, has been formed to undertake general machinery trading in Ireland. The general manager of the new company is Mr. E. P. Purcell.

Durgapur Steel Works and Foundry

A new steel works is being built at Durgapur, 118 miles from Calcutta, by the Indian Steelworks Construction Company, Limited (ISCON—a British consortium of thirteen manufacturing and electrical firms). Commissioned by the Indian Government, the works will cost £100,000,000 and is expected to be in operation by the middle of 1960. In the following article the individual departments, and equipment of the new foundry which forms a part of the works are described.

The new Durgapur Steel Works foundry will be equipped for the production of approximately 20,000 tons of ingot moulds, 5,000 tons of general iron castings and 5,000 tons of steel castings per annum. Raw materials will include foundry iron in the form of cold pig from the pig-casting machine, together with selected mill scrap and coke. Iron-melting facilities will be provided by four cupolas, each of ten-tons per hr. capacity, and iron castings of up to 15 tons net wt. will be produced. Steel melting will be carried out in an electric-arc furnace of 6-ton nominal capacity. Non-ferrous melting will be done in two gas-fired tilting-crucible furnaces of ½-ton, and ¼-ton, capacity respectively.

The construction of the patternshop and iron foundry is being programmed so that facilities will be available for the manufacture of the initial supply of ingot moulds during the six-months period prior to the start up of the open-hearth steel plant. Arrangements are therefore being made for the early training of the patternmakers and iron-foundry personnel.

INTENDED LAYOUT OF THE FOUNDRY

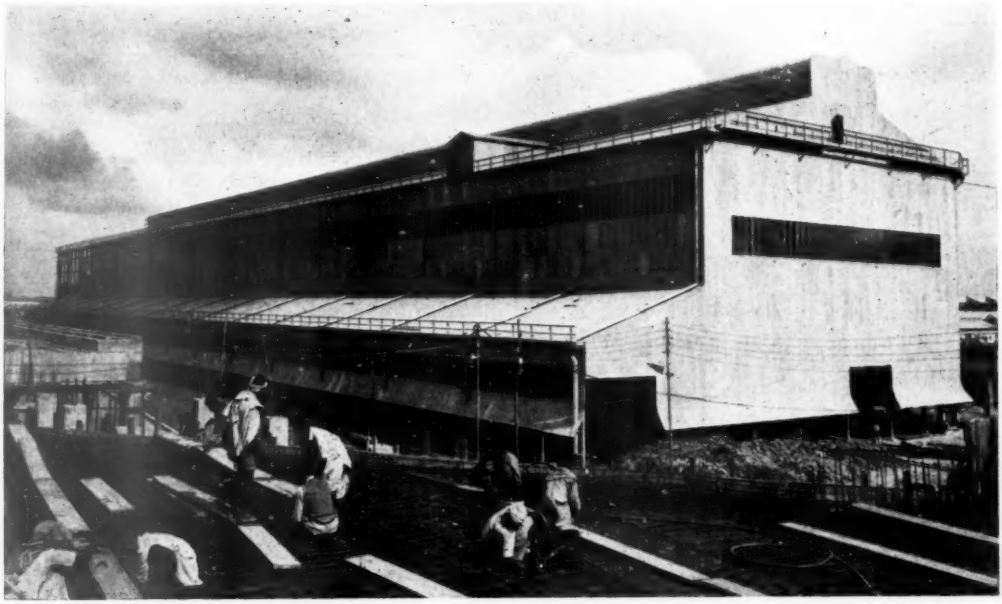
Stock Bay

The cold pig-iron, together with mill scrap and coke, will be delivered by rail wagons to a stock bay, which will have space for one week's supply of scrap. Provision will be made for breaking standard cast pigs, but steel scrap will be cut to convenient lengths before leaving the rolling mills, and discard moulds to be remelted in the foundry will be broken before delivery. Materials will be charged direct into the cupola weigh-hoppers and arc-furnace charge-baskets by an overhead crane with grab or magnet.

Metal Melting

The four iron-melting cupolas will be arranged for mechanized bucket-charging in pairs, one cupola in each pair being operated each day. Thus 20 tons of molten iron will be tapped every hr., and iron castings of up to 15-tons weight produced. The molten steel from the 6-ton arc furnace will be

Exterior of the wheel and tyre ingot-casting shop at the Durgapur Steel Works.



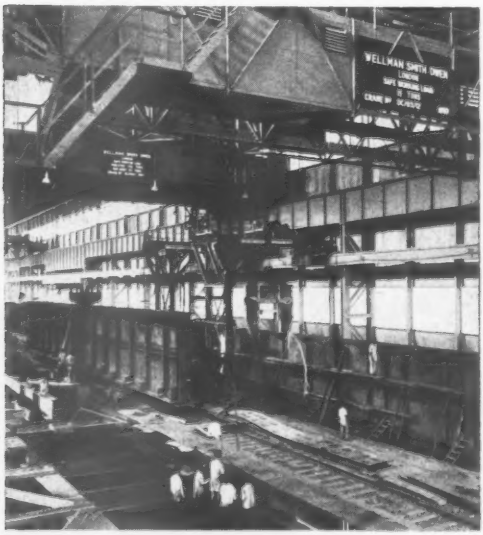
Last stages of shop erection (at the works of Davy and United Roll Foundry, Limited) of a 42-in. blooming mill destined for the Durgapur Steel Works.

tapped into ladles taken into the moulding bay by electric transfer-car. Space will be allowed for the installation of a second arc-furnace at a later date. The combined capacity of both furnaces will enable castings up to about 15-tons gross wt. to be produced. The non-ferrous crucible furnaces will feed hand-shanks for floor-casting.

Sand Preparation

A central moulding-sand preparation-bay will house one sand plant of 25 to 30-tons per hr. capacity (for ingot moulds and iron castings), one of 12 to 15-tons capacity (for steel castings), and one of 5-tons per hr. (for small moulds, facing sands, and sand for non-ferrous castings). Core-sand will be mixed in a separate unit of 3-tons per hr. capacity, but ingot-mould cores will be made from the same sand as the outer mould. Facilities for bonding additions will be provided in each sand plant, to cater for the diversity of properties in the basic sands.

View of the interior of the wheel and tyre ingot-casting shop at the Durgapur works.



Main Moulding-bay

The main moulding-bay will house all work on ingot-mould, large iron, and steel castings, including the moulding, closing, pouring and knockout operations. Fifteen sunken pouring-stations, with raised walkways, are to be provided for casting ingot-moulds; sand-mould assemblies will be transferred here when the cores and outer sand-moulds have been independently dried and brought together for pouring. All ingot-mould outsides, and cores, and all steel-casting sand-moulds will be dried in fixed stoves. Sand-moulds for large iron and steel castings such as slag pans, which cannot be machine- or box-moulded, will be dried by means of portable stoves. General foundry-tackle castings, and ingot-mould bottoms, will either be cast in open sand or will be box-moulded and dried. Cranes to handle box moulds of 35-tons wt. will be provided to serve the main moulding-bay.

Small-castings Foundry

The small-castings foundry adjacent to the main moulding-bay, to which molten iron and steel will be supplied by ladle-transfer bogies, will cater for box-moulding by both machine and hand, and open sand-work. Non-ferrous-metal castings and cores will also be produced in this bay.

Moulding Machines

The layout of the moulding-floors and sand-plants will provide for considerable flexibility of operation within the limits of capacity of the moulding-machines. These machines will include one plain jolting-machine of 10-tons capacity, one rollover type of 2-tons capacity with one sand-slinger in the steel foundry, five sandslingers in the heavy iron-foundry for ingot moulds etc., and two ½-ton jolt-rollover and two hand-operated moulding-machines for small iron and steel castings and non-ferrous castings.

Knock-out

All the ingot moulds poured on any one day will be placed on one section of a 60 by 40-ft. static knock-out grid. This grid will be divided into five sections of 60 by 8-ft., each with its own sand-conveyor and dust-collecting ducting, to which the exhaust fan may be connected by sections so that each day's work may remain on the grid to cool for one week. Steel castings, and pit-moulded castings, will be transferred to a 40 by 5-ft. static knock-out grid, whilst small iron-, steel- and non-ferrous-metal castings will be knocked out on a 6 by 4-ft. vibrating grid, or on the floor for heap reconditioning of the sand.

Fettling

The ferrous castings will be taken by transfer bogies to the fettling shop, where the ingot-moulds will be dressed by hand (using portable electric grinders and pneumatic chipping-hammers). Intricately-cored castings will have the sand removed by Hydroblast, while medium iron and steel castings will be cleaned on a swing-table Wheelabrator. The Hydroblast will have both an externally-operated, and an inside, gun. Small castings will be fettled with hand-tools on benches, or against grinding wheels, and will be cleaned in a Wheelabrator Tumblast machine.

Ancillary Plant

A foundry laboratory will be provided for the routine control of the cupola- and arc-furnace metal analyses, and sand-mixes, only. All the mechanical testing, however, will be carried out in the central laboratories of the project. A pattern-shop is being provided with machines and hand-tools for wooden patternmaking, and some non-ferrous-metal patternmaking. The gas-fired stoves and furnaces will burn semi-purified coke-oven gas containing hydrogen sulphide, having a calorific value of 450 to 500 B.Th.U's per cub ft.

Early Methods of Quality Control

By Kenneth J. Haycock

The technical resources at the command of the foundryman today are considerable, but it was not always so. To look back with condescension on the efforts of our predecessors is very easy; but let it not be forgotten that they were working by trial and error, and the intelligent application of results. They did not do too badly!

Techniques and methods developed in the early days of the foundry industry were often closely-guarded secrets, concealed by cabalistic mumbo-jumbo. Without the benefits of trade and research associations, textbooks and journals, our predecessors were slowly building the foundations of present-day knowledge. Our forefathers were quite capable of using modern technique, and only lacked to-day's accumulated knowledge.

Assessment by "Rule of Thumb"

The following most interesting account was written a century ago by a forgotten pioneer named Grier:—

"When cast-iron is fractured, it exhibits a grey colour, sometimes approaching to dull white, and, in other cases, to dark grey, with spots nearly black. The lustre is sometimes metallic, resembling freshly-cut particles of lead lying on the surface; and, in other cases, there seem to be crystals in the iron disposed in rays.

"When the colour is a uniform dark-grey, the iron is tough, provided there is also metallic lustre; but if there be no metallic lustre, the iron, though soft, will be more easily crumbled than in the former case. The weakest sort of soft cast-iron is where the fracture is a dark hue, mottled and does not shine.

"The iron may be accounted hard, tenacious, and stiff, when the colour of the fracture is lightish grey with a high metallic lustre. When the tint is light grey without metallic lustre, the iron is hard and brittle. If the hue is dull white, the iron is more hard and brittle than in the last case. When the fracture is greyish white with small radiating crystals, the iron is of the extreme degree of hardness and brittleness.

"The best way to try the quality of cast-iron is to strike its edge with a hammer. Should the blow make a slight impression the iron must be in some degree malleable, and, if the specimen be uniform, it may be regarded as good for machinery; if, on the contrary, the hammer makes no impression and fragments fly off, the iron is brittle, and consequently, bad. The soft cast-iron yields readily to the file after the outer crust had been removed, and is, in a cold state, slightly malleable.

"The quality is also easily judged, when in the melted state, from the nature of the agitated aspect of its surface. The mass of fluid seems to undergo rapid circulation within itself, including a constant tremor on the surface, having the appearance of an ever-varying network; when this network is minutely subdivided it indicates soft iron. If, on the contrary, the iron be thrown up in large convolutions, the quality of the metal must be hard."

These early applications of a sort of quality control were the basis of the foundry industry's present vast accumulation of techniques.

Costing of Patterns

Mr. John L. Carter (cost consultant to the Gray Iron Founders' Society, Incorporated, of America), in an article entitled "Policy and Practice in the Handling of Pattern Labour and Expense" presented in *Gray Iron News*, gives some useful hints as to how problems which arise should be tackled. The following abstract has been made from his article.

Charging for New Patterns

It is the custom of the foundry trade for buyers of castings to pay for the production of patterns, and their maintenance in proper condition. In the majority of cases the customer either makes his own patterns, or buys them from master pattern-making shops; alternatively, the customer may ask the foundry to quote together for castings and pattern equipment required.

Casting-plus-pattern quoting

In dealing with such inquiries a foundry may quote a price for the castings which includes the cost of the pattern equipment. However, there are many objections to this practice from the point of view of both seller and buyer. The principal objection is that a fair comparison of quotations made on this basis is difficult, because some foundries may count on absorbing the pattern cost in the cost of the first order, and others on spreading the pattern cost over the total quantity which the customer is expected to order over an extended period of time. A foundryman who is very hungry for business may estimate probable future requirements at such a totally unrealistic figure that, in effect, he comes close to omitting the cost of the pattern equipment altogether.

It is hardly necessary to point out that the spreading of pattern cost over anticipated future requirements is a very risky policy. There are many reasons why the anticipated future orders may never come through, such as:

(1) The customer may not sell as many of the products, in which the casting is used, as he expected to. (2) The casting design may be altered, and new patterns required. (3) The line of products in which the casting is used may be abandoned. (4) The job may be lost to a competitor. In addition to these objections, there is the possibility that some foundries will substantially under-estimate the cost of the patterns for various reasons. Also, the type or quality of the pattern equipment used by different foundries may vary.

Separate Costing is Clear-cut

In the old days, the practice of absorbing the cost of the patterns in the casting price was fairly common, but as foundries have become more cost-conscious this practice has been abandoned by firms. Most buyers, as well as sellers, have come to realize that separate prices on castings and patterns provide the most clean-cut, fair and business-like basis for deciding between competitors. Quality, as well as price, is an important factor in buying patterns, and separate prices enable the buyer to judge intelligently.

Quality, Service and Price should be the primary considerations in selecting a source of supply for castings.

Charging for Mounting Patterns

A somewhat similar situation arises when a founder receives an unmounted pattern from a customer and decides to mount it (or make a plate pattern from it), and make the casting on a moulding-machine. He may either:

(*a*) Offer the customer a reduced price if he will pay for the improved pattern equipment, or

(*b*) Make no reduction in price, make the improved pattern equipment at his own expense and pocket the savings from the reduced cost (which may in some cases amount to considerably more than the cost of the improved pattern equipment). There is nothing unethical about the second course, but there are certain considerations which, in the writer's opinion, make the first course highly preferable. These are:

(1) It makes a good impression on a customer to show him how he can save money on his castings by improved pattern equipment, improved casting design, or in any other way.

(2) If the founder charges the customer a price based on hand-moulding, and a competitor quotes a lower price based on machine-moulding, the customer may think he has been deliberately overcharged.

(3) It is usually necessary to get samples approved whenever new patterns are involved, and in such cases the customer is bound to be aware of the fact that different pattern equipment has been made.

The above considerations should carry some weight when expenditure for improved pattern equipment is substantial, but they do not apply to simple "flatbacks," which can be easily mounted on a board and removed when the order is completed. However, even in these cases, if the foundry runs are short the cost of gating and mounting should be considered carefully.

Control of Pattern Costs

The best way to effectively control pattern costs is to set up the pattern department as a separate cost division, with a complete set of departmental accounts. The value of this procedure in accurate

Costing of Patterns

estimation of costs would alone make it worthwhile, but it also has the following advantages:

(1) The separation of pattern costs from casting costs makes the records of both more accurate, and allows better control. When a separate pattern cost division is not in existence many items of pattern cost, such as "material," "supplies," "repairs," etc., and even "direct labour," are usually so mixed up with casting costs that they are lost sight of, and practically no control is exercised over them.

(2) Records of profit on pattern sales stimulate closer control of costs on customers' patterns, and of pattern labour and expense.

Reasons for Close Control

In a great many foundries the control of pattern labour and expense is very loose and ineffective, or almost totally lacking. Yet it is exceedingly worthwhile, for the following reasons:

(1) Skilled patternmaking labour is expensive.

(2) Inefficient scheduling of a patternmaker's time causes waste of time.

(3) The efficiency of a patternmaker's performance is likely to decline unless it is systematically supervised and checked.

(4) A good deal of pattern work that should properly be charged to customers is likely to be charged to "foundry expenses" unless care is taken.

(5) Some customers may provide consistently old or unsatisfactory patterns, that are continually in need of small repairs (which are not charged to the customer, but which mount up to a considerable cost over a period of time). Such a situation must be remedied.

(6) Control of casting costs will be much more effective if it is not confused by the inclusion of "pattern labour and expense."

Latest Foundry Statistics

Copper-base Castings. The June *Bulletin* of the British Bureau of Non-Ferrous Metal Statistics reports that output of copper-base castings during June was 5,675 tons and that for the half year it was 36,645 tons as compared with 37,293 tons in the first six months of 1958.

Steel Castings:—According to a special *Bulletin* issued by the British Iron and Steel Federation, the average weekly production of steel for making steel castings during June was 10,200 tons. For the month of May, the estimated weekly average output of steel castings was estimated at 3,700 tons.

RATHER LESS THAN two years ago Shell-Mex & BP, Limited, established a big oil storage and distribution centre in the port of the Tees, the use of which has expanded so rapidly that a big extension scheme increasing the capital expenditure to about £1,000,000 has been approved. More new storage tanks with capacities of up to 12,000 tons are to be built by Whessoe, Limited, Darlington. Four and a half miles of pipes are to be laid and the work is due for completion in the autumn of next year.

Botting Material and Casting Defects

Mr. A. D. Morgan, in Report No. 506, on "Cupola Botting Materials and their Relation to Casting Defects" (published by the British Cast Iron Research Association), discloses work which stresses the great value of the Association to industry. From long experience, practical writers, like Mr. James Timbrell, have made sensible recommendations on botting procedures, but few of them ever connected defects in castings to bad botting practice. Mr. Morgan has made a simple calculation that a 2 tons per hr. cupola will deliver into a 5-cwt. ladle one pound of clay residue per hr. and this is a source of danger in promoting slag defects in castings—a source of trouble which has seldom been suspected. No fewer than 26 sorts of compositions from different foundries were tested in the Association's laboratory for firing contraction, fusion point and drying contraction and, of course, commented upon in a very useful "remarks" column. From this table of the Report now published and the excellent illustrations, it is easy to see which types of materials should be avoided.

The following quotation from the Report will serve to show its worth to the practical foundryman, based as they are on a scientific investigation:—"From these results and observations, it is possible to recommend materials for botting mixtures and their approximate proportions. (Type A mix is best used where frequent botting is employed on small cupolas, and type B where long gathering periods are used and a larger taphole is employed).

Type A.

Fireclay (30 to 50 per cent, clay grade) plus coal-dust (low ash 11 per cent. max. Superfine grade) 10 to 20 per cent. or sawdust (medium-fine sawings) 2 to 10 per cent.

Type B.

Fireclay (30 to 50 per cent. clay grade) 50 per cent., black sand (silica coresand) remainder, coal-dust (low ash 11 per cent. max., fine grade) 10 to 20 per cent. or sawdust (medium to coarse sawings) 2 to 10 per cent.

The materials are best mixed when dry in a bucket, and water is gradually added with thorough beating and kneading before use. It is preferable to prepare the stiff mixture the day before use and keep covered with a wet sack.

(The proportions given above are similar to those recommended by Timbrell." (FOUNDRY TRADE JOURNAL, 1941, **64**, June 5, p. 377, and 1946, **78**, January 24, p. 93)).

Machine-tool Industry looking-up

Considerable improvement in the trend of the UK machine-tool industry is indicated by the figures for new orders during May. In the domestic market there was a rise of over 20 per cent. in the volume of orders, and export orders in May were also substantially higher. The industry's total order-book increased by £1,250,000 to £51,660,000. The May home market orders were £6,166,000, compared with £4,935,000 in April and £4,171,000 in May, 1958.

Deliveries also rose—to £5,229,000 in May, compared with £4,854,000 in April and £4,996,000 a year ago. The order-book at the end of the month was £937,000 higher than in April, but £13,772,000 down on a year ago and it has as far again to go to reach the peak of August, 1956.

Equipment and Supplies

Bale-out Furnace for Aluminium

The industrial department of the West Midlands Gas Board have recently been giving consideration to the design of bale-out furnaces normally used for melting and holding aluminium. Gas-fired units were often inefficient in operation and did not present the best of conditions for the operator, who was in close proximity to the furnace throughout the whole of the working day. During the development of prototypes, therefore, particular attention has been paid to fuel consumption, and comfortable conditions for the operator (see Fig. 1).

Description of Prototypes

In order to improve the overall efficiency of the furnace, a recuperator has been included which utilizes the outgoing flue gases to preheat the air for combustion. The burner is of the air-blast type, using air at pressures of 14 to 20 in. w.g. The recuperator, together with the necessary gas governor, back-pressure valve, and motorized valves for temperature control, have been accommodated within the main casing, thus providing a neat and compact "packaged" unit ready for connecting to the appropriate gas and air supplies. With slight modification, it would be possible to accommodate the fan unit within the main casing, although, generally speaking, most die-casting shops have one or more blowing fans serving several holding-pots. In order to maintain a reasonably cool casing a generous amount of insulation has been provided, and the flue is of the double-wall type of construction providing an annulus for cold air to flow around the flue proper.

Cheaper than Electric Unit

Two sizes of furnace have been constructed as prototypes, the first having a capacity of 150 lb. and the second a capacity of 300 lb. The 150-lb. furnace has been in extensive use in a large die-casting shop, and a comparison made with a similar-sized electric unit showed that the running costs for holding with a small amount of melting were much lower with the gas-fired unit. Incandescent Heat Company, Limited, of Smethwick, Staffs, are one of several firms who are prepared to quote for these designs.

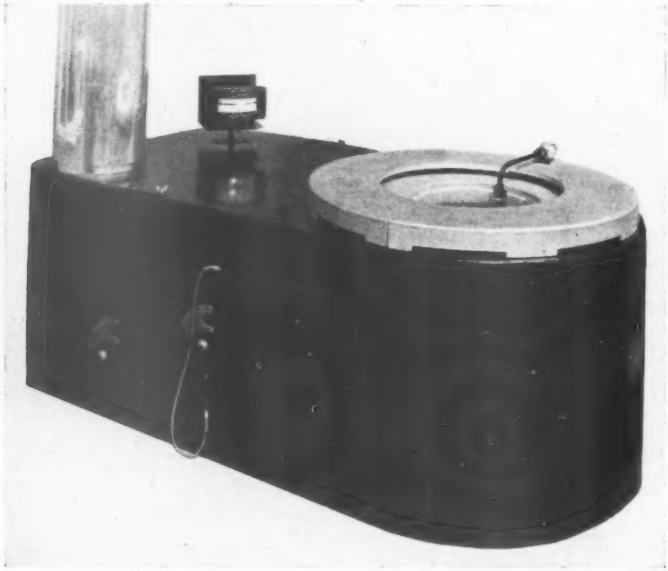


FIG. 1.—*Prototype bale-out furnace for melting and holding aluminium, developed by the West Midlands Gas Board.*

Double-insulated Drills

Wolf Electric Tools, Limited, Pioneer Works, Hanger Lane, London, W.5, have introduced double-insulated drills for industry: DI-K2c ¼-in. capacity general-duty, DI-K12c ¼-in. capacity low-speed, and DI-K3c ⅜-in. capacity general-duty, drills. In addition to the normal insulation incorporated in standard electric tools, the drills have a second independent insulation between the current-carrying parts and the outer casing. This has been done by completely lining the body and handle with an insulating shell. The drill switch-cover is made of toughened glass fibre, and an insulating sleeve is fitted between the armature shaft and windings. The ventilation fan is moulded from plastic, and the entry bush and cleat made from nylon. The insulation of every unit leaving the works is finally tested at 400v.

Sand Testing

Foundry Suppliers, Limited, 25a, Cockspur Street, London, S.W.1, have available an apparatus on which it is possible to test the rigidity of green cores by traversing a standard core specimen along a roller conveyor until it fractures, then measuring the length of core broken off. A second apparatus which has been introduced is for the evaluation of actual specific surface of sand samples in sq. cm. per gm. It is used in conjunction with a sieve analysis. Both machines are made by George Fischer, Limited.

THWAITES ENGINEERING COMPANY, LIMITED, Cubbington, Leamington Spa, announce that they are now marketing a new streamlined Nimbus 15-cwt. diesel dumper, with improved load-moving capacity and a lower centre of gravity.

BAKELITE, LIMITED, 12, Grosvenor Gardens, London, S.W.1, announce the publication of their advance information sheet E.32, which gives full details of three new low-cost epoxide-resin hardeners now being marketed by the company.

DOHM, LIMITED, 167 Victoria Street, London, S.W.1, have developed a new polythene heavy-duty bucket which is claimed to be non-corrosive and virtually unbreakable. Obtainable in battleship grey, the bucket is specially designed to withstand the roughest treatment. It has a reinforced top rim, sides and bottom, and a full-sized lip makes it easy to pour liquids and mixes of all kinds.

European Investment Casters' Conference

Survey of Proceedings at Essen: May 31 to June 3

Following the pattern of recent times—when successive annual conferences have been held in Holland, the UK, and Paris—this year's annual meeting of European investment founders was held in the German industrial centre of Essen, with German investment founders acting as hosts. Mr. John Bolton, secretary of the British Investment Casters' Technical Association (BICTA), attended the conference and has supplied the following special report on the general proceedings.

The sixth European conference of investment founders was held in Essen from Sunday evening, May 31 to Wednesday, June 3, and was attended by 72 delegates from 10 countries, many of the delegates being accompanied by their ladies. The programme included an informal reception on the Sunday evening; an official welcome on behalf of the civic authority of Essen and the German investment founders; 12 specialist lectures and one general-interest lecture on art castings of about the year 1800; the annual business meeting; two castings competitions; a visit to the Krupp research laboratories; a most delightful annual dinner (with only two brief speeches); a visit to the Villa Hügel; and ample opportunities for informal contacts which form so valuable a part of such international gatherings. The ladies were entertained by sightseeing tours and visits to places of interest in and around Düsseldorf and Essen, as well as a visit underground at a coal mine. It is difficult to imagine a more profitable and enjoyable conference. Under the presidency of Mr. H. J. Meerkamp van Embden, of N.V. Philips Gloeilampenfabrieken, the proceedings were conducted with smoothness and informality. To the president's own outstanding linguistic ability there was added the amenity of an excellent simultaneous translation service for the technical sessions.

The *Haus der Technik* at Essen, where all the meetings were held, is an excellently appointed centre for the holding of technical conferences. Several suites of rooms are available, the largest lecture hall having a seating capacity of 1,000, in tiered seats. Each seat is equipped with a built-in microphone and a push-button switch to operate a signal light on a console at the chairman's table. The chairman is thus able to connect each speaker's microphone in turn to the simultaneous, three-language translation service. The quality and scale of the visual-aid equipment is also of the highest order, and the disposition of microphones at the speaker's rostrum is such as to enable him to move from lecturer to demonstration bench or screen, without affecting his audibility. Apart from the lecture halls, the *Haus* also contains a refreshment room, and other amenities appropriate to a first-class conference centre. No apology is made for interposing this eulogy of the meeting accommodation at Essen, for British readers, in particular, will unfortunately be all too familiar with the inadequacy of proper conference facilities in the United Kingdom.

Some of the delegates and ladies attending the 1959 *European Investment Casters' Conference at Essen. In the centre is Mr. H. J. Meerkamp van Embden, president, with Dr. W. Tofaute of Fried, Krupp (left) and direktor E. M. Shönböck of Gebr. Bohler & Co.*

European Investment Casters' Conference

Opening Ceremony

The conference was formally opened on June 1 by the president, Mr. Meerkamp van Embden, who was followed by the Mayor of Essen, Oberbürgermeister Wilhelm Nieswand, who welcomed the delegates and their ladies to Essen, and emphasized the efforts which the city authorities are making to make the town a centre for international technical meetings. A welcome on behalf of the German investment castings industry was given by Professor Dr. R. Scherer, president of the board of management of Deutsche Edelstahlwerke, Bochum. He surveyed the development of the investment castings industry in Germany and pointed to its vast potentialities in the future, providing, as it does, a method of machine construction giving an unprecedented freedom of design in an unusually wide range of materials.

Annual Business Meeting

Hitherto the organization behind these European conferences of investment founders has been quite informal, and has been largely dependent upon the enthusiasm, initiative and ability of Mr. Meerkamp van Embden in consultation with the industry in the host country. It is true that reference to a European Investment Casters' Association has been made for several years, but in fact no such formal organization—as understood in British industry—has been constituted. The continuing success of these meetings has, however, made it necessary that some revision should be made with a view to relieving the president of his heavy burden of duties, and to ensure future continuity.

Ways and means of achieving this end were discussed at the business meeting held in the afternoon of June 1, and informally during the conference, with the result that before the end of the conference the president was able to announce that agreement had been reached with each of the national groups for the establishment of a committee which is to be responsible for the organization of the 1960 conference in Belgium, and with presenting specific proposals for the future constitution of the international organization. This committee will comprise: Mr. Meerkamp van Embden (president); Mr. P. Chevé (Société des Acieries et Forges de la Loire); Mr. B. J. Helders (N. V. " Industrie "), treasurer; Dr. K. A. Krekeler (Gebr. Böhler & Company); Mr. P. Mathy (S.A. Usines Gilson); and a representative from the United Kingdom. In the meantime the necessary finances are to be secured by donations from companies who participated in the conference.

Next Conference

The 1960 conference is to be held in Belgium, at the invitation of M. Mathy, during the first few days of July, 1960, where the primary topic for discussion will be the design of test-pieces and the mechanical properties of investment-cast material. Invitations were extended to the British Investment Casters' Technical Association and the sub-committee for investment castings of the *Verein Deutsche Giessereifachleute* to report to the next conference on their activities, particularly in relation to national specifications.

Mr. Meerkamp van Embden also announced the arrangements he had made for the issue of *Proceedings* of the 1958 and the present conference and paid tribute to the facilities for publication which had been placed at the disposal of the organization by the FOUNDRY TRADE JOURNAL.

Attention was also drawn to the need for a literature abstracting and information service being available to investment casters throughout the world. In this connection Mr. J. Bolton, of the British Investment Casters' Technical Association, spoke of the publication, *Investment Castings Abstracts*, published by the Association to members (by arrangement with the British Steel Castings Research Association) and undertook to explore the possibility of this service being made more widely available.

Arising from the presentation of the paper by M. Mathy earlier in the conference, agreement was reached that an attempt be made prior to the next conference to collect data from participants on the low-temperature impact properties of investment-cast plain-carbon and low-alloy steels.

Castings Competitions

The holding of competitions for investment castings has become a regular feature of these conferences, two diplomas being offered; one in respect of the best example submitted and the other for the casting exhibiting the greatest potential for the future development of the process. Each contestant is allowed a few moments at the meeting to describe his exhibits and to advance his claims, and each company represented at the conference is allowed one vote in each contest.

The contest on this occasion was held in the afternoon of June 2 and attracted entries from eight companies, namely: Gebr. Böhler & Company, Düsseldorf; Société des Forges et Ateliers du Creusot, Paris; Deutsche Edelstahlwerke, Bochum; Firth-Vickers Stainless Steels, Limited, Sheffield; N.V. " Industrie," Vaassen; Microfusion, Paris; N.V. Philips Gloeilampenfabrieken, Eindhoven; and Trucast, Limited, Farnham Royal. The winner in both sections of the contest was declared to be Dr. E. G. Nickel of Deutsche Edelstahlwerke for his entry of a rotor casting of exceptional quality and design, and the presentation to him of the diplomas was made by the president at the annual dinner held on the same evening.

Annual Dinner

The dinner, attended by about 120 delegates and their ladies, was held in most charming surroundings at the Schlosshotel Hugenpoet at Kettwig, the guests being received by the president and Mrs. Meerkamp van Embden and by Mr. and Mrs. E. M. Schönböck and Dr. and Mrs. W. Tofaute representing the German hosts. In a brief speech delivered in German, French and English, the president expressed the pleasure and thanks of the conference participants to German investment founders for their generous hospitality; his remarks

were supported by Mr. J. Aherne Heron; and Mr. Schönböck responded.

Technical Sessions

The twelve technical papers presented for discussion at the conference occupied seven sessions. Brief details of these papers are provided in the following review:—

Attitude of Gunsmiths to Investment Castings

By P. Mathy (Société Anonyme Usines Gilson)

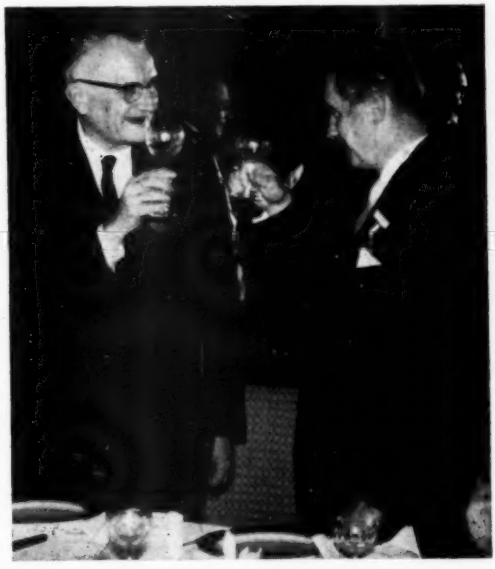
The author explained that gunsmiths in Belgium could be divided into three groups: (*a*) the "one-man" family businesses offering high-quality products in very small quantities; (*b*) small manufacturers employing between 10 and 100 persons and making good-quality products; and (*c*) very large manufacturers who have established extensive machine-shop capacity for quantity production. The first category, he said, was of little interest to the investment founder because of a complete lack of standardization; the second group at present provided the best market; but the third classification offered the greatest potential if certain prejudices could be overcome. These prejudices, he said, were (*a*) the mistaken belief amongst users that the anisotropic properties of wrought components were advantageous; (*b*) that claims for the dimensional accuracy of investment castings had been overstated in former years, and machining was still required; (*c*) the surface quality (due to decarburization) of investment castings in some materials was disadvantageous; (*d*) in some instances parts were required in quantities too large for economic production by investment casting. M. Mathy maintained that investment founders were, or ought to be, in a position to dispel most of these prejudices. For example, the isotropic properties of castings were definitely advantageous, particularly was this true with respect to impact properties; however, so far insufficient quantitative data were available to convince the engineer. Furthermore, surface decarburization could be overcome by gaseous case-hardening.

The second part of the paper propounded a programme of investigation which the author recommended should be carried out by collaborating foundries in different countries with a view to providing data on impact properties. This programme would initially require standardization of the test-bar form and would include determination of the effect on impact values of the carbon content of plain-carbon steels; and the influence of heat-treatment and trace elements in plain carbon, Ni/Cr, and Ni/Cr/Mo steels and cobalt alloys.

Batten-Cordonnier System for the Classification of Technical Literature

By C. Jouwersma (Philips Gloeilampenfabrieken)

This paper described a punched-card system used by the author's company for indexing technical literature, including a large volume of patents specifications covering a wide range of subjects. He explained how, by expert selection of subject classifications, the system provided a simple-to-use index which ensured comprehensive retrieval when reference was needed, and illustrated his remarks by some typical demonstrations. Mr. Jouwersma drew attention to the apparent absence of an international literature-information service related specifically to investment castings.



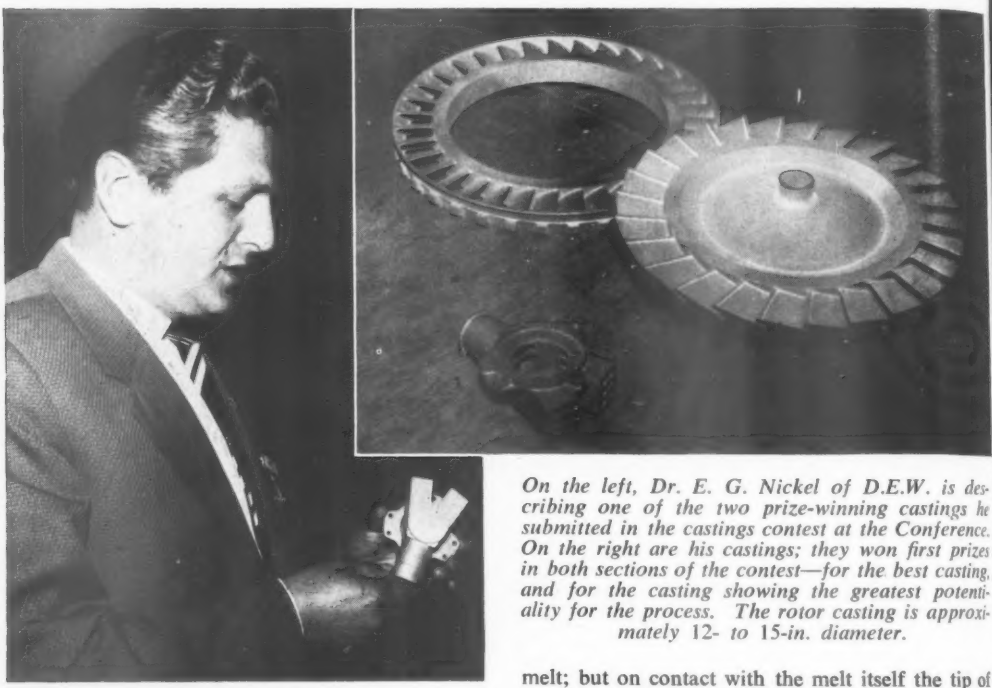
Mr. Meerkamp van Embden and Direktor Shönböck drinking the toast to the German hosts at the Conference dinner.

Position of (German) Specifications for Investment Castings

By Dr. E. G. Nickel (D.E.W.)

Dr. Nickel's paper disclosed that the technical committee established by German investment founders has collaborated with users in the preparation of a comprehensive range of steels suitable for investment casting, the choice having been made primarily in relation to ease of casting and machining. The materials selected had been based on normal commercial types of steels, but compositions had been modified where necessary with a view to improving founding properties, thereby providing an improved product. The steels agreed upon so far were: Case-hardening steels (four compositions); heat-treatable steels (four compositions); nitriding steels (2.3 per cent. Cr; 0.15 per cent. Mo; 0.1 per cent. V); tools steels (five compositions); corrosion-resisting steels (seven compositions); and heat-resisting steels (five compositions).

Some progress has also been made towards



On the left, Dr. E. G. Nickel of D.E.W. is describing one of the two prize-winning castings he submitted in the castings contest at the Conference. On the right are his castings; they won first prizes in both sections of the contest—for the best casting, and for the casting showing the greatest potentiality for the process. The rotor casting is approximately 12- to 15-in. diameter.

determining the mechanical properties of these materials in investment-cast form. A design of separately-cast test-bar (with the feeder-head situated over the gauge-length) was to be adopted, and the programme of testing on which the industry was now embarking had been designed to study the effect of heat-treatment and decarburization on properties, and the variation of properties with section thickness.

Estimation of the Temperature of a Melt

By H. J. Meerkamp van Embden (Philips Gloeilampenfabrieken)

After reviewing existing optical methods depending upon measurement of total and surface radiation, and immersion pyrometry techniques (which it was explained were expensive and required skilled supervision), the author described a method and equipment which had been evolved by his company. In this, 2-mm. dia. Pt/Pt-Rh thermocouple wires were insulated by unfused refractory (such as magnesia) which in turn was encased in a nickel tube, the whole being swaged down to a small diameter, and closed at the end to be immersed in the melt. The whole length of the noble-metal thermocouple was thus continuously insulated and protected by the nickel sheath, and was sufficiently flexible to be conveniently wound on to a small pistol-grip drum which could be carried by the operator. The purpose of the nickel sheath was to prevent contamination from slag covering the melt; but on contact with the melt itself the tip of the sheath was melted and the liquid metal formed the hot junction across the thermocouple wires. Separate nickel caps were provided to re-seal the end of the thermocouple after each dip.

Advantages claimed for this method were greater speed and ease of operation, less skill required, and an accuracy equal to the best immersion-pyrometry practice. Contamination of the thermocouple was avoided and the consumption of precious-metal wire was reduced, since no more than 1 cm. need be removed at one time. The author did not think contamination of the melt by nickel was likely to be a serious disadvantage, but, if necessary, alternative sheathing materials could be found. The presentation of this paper was accompanied by a practical demonstration.

Investment Casting Alloys for Service at Elevated Temperatures

By D. R. Wood (Mond Nickel Co. Ltd.)

This paper which had previously been presented at the BICTA Annual Conference* in London, reviewed the available iron-, cobalt-, and nickel-base alloys of particular interest, and reported data on tensile properties; resistance to high-temperature stress rupture; fatigue; and oxidation rates. The improvement in the mechanical properties of Nimocast 258 and an experimental nickel-base alloy attendant upon vacuum melting was also referred to.

* Printed in the JOURNAL of June 4, pages 663-668.

Technical Communication between Investment Founders and their Customers

By R. Schwedes (Lawrence Laboratories Inc., USA.)

Mr. Schwedes, who is president of the Investment Casters' Society and a director of the Investment Castings Institute of America, gave a detailed description of the organization of a "Design Clinic" conducted by these two Societies at Santa Monica, California, on March 17 last, which attracted an attendance of over 200 design engineers and other representatives from user industries. Admission was by invitation distributed through sales organizations of participating investment founders, the view being taken that this first conference should be directed towards increasing the knowledge of existing customers rather than trying to extend their number directly. The programme consisted of an exhibition of castings and four lecture-sessions on design, applications, alloys and specifications (acceptance standards).

Investment Casting of Precious Metals

By P. E. Gainsbury (Mond Nickel Co. Ltd.)

This paper reviewed modern methods employed for the production of dental and jewellery castings in noble metals and alloys. The author indicated certain techniques used in these industries which he thought might, with appropriate modifications in some cases, be applicable to the production of engineering castings. He explained the use of rubber dies which were applied on account of the highly intricate nature of the castings being made and the short length of production runs; a technique for pressure pouring using steam pressure; single-coat investment techniques, and the use of vacuum rather than vibration for consolidation of the investment.

Metallurgy of Steels and High Alloys

By R. Waindle (Wai Met Alloys Company, Detroit)

Mr. Waindle prefaced this lecture with a review of some trends in the US investment castings industry. He said that design engineers were coming to the conclusion that the tensile test was an inadequate criterion of assessment, tending to favour wrought materials. Ductility and impact value were tending to be preferred to tensile, but were not sufficiently understood. For example, in comparative assessments of cast and wrought cutting tools, the cast cutters had only 20 per cent. of the impact value of the wrought products, but gave three times the "life." Conventional laboratory assessment would have resulted in these castings being discarded. In the aircraft industry, cast materials with zero transverse ductility were being used regularly and successfully.

Mr. Waindle said he did not agree with the current emphasis on nickle-base super alloys, for not only were they difficult to handle in the foundry, but were subject to corrosion and oxidation effects in service, in some cases grain-boundary oxidation —"green rot"—had occurred after only 50-hr. service. His own view was that cobalt-base alloys were to be preferred at temperatures exceeding 1,000 deg. C. As regards surface protection, progress was being made in the application of aluminium cladding to alloys for turbine blading. Its advantages included: (*a*) up to 50 per cent. increase in resistance to thermal shock; (*b*) improved creep resistance; (*c*) improved resistance to erosion; (*d*) the fact that alloys having good castability but whose properties were not regarded as being sufficiently good for present conditions of service, could be reinstated.

Figures were provided on the rapid rate of adoption of the ceramic-shell technique of investment. A recent survey had disclosed that 14 out of 28 companies in America were now using the process or on the point of doing so, and 13 others were investigating its application.

Mr. Waindle said the automotive gas-turbine was in active development for industrial vehicles in the USA. Some three years ago it had been thought that little progress would be made in the employment of investment castings in this field on account of the high cost, but in fact the most-expensive vacuum-cast nickel-base alloys were now being specified.

On the subject of vacuum casting, the author said he was of the opinion that the improved properties claimed for vacuum-cast material were at least partially due to the improved standards of production control inherent in the technique. He considered, alternatively, that alloying techniques could result in equivalent improvements in properties and would be cheaper.

Wax Moulding and Dimensional Tolerances

By C. Nieuwenhuis (Philips Gloeilampenfabrieken)

The chemical and physical factors affecting the dimensional accuracy of wax patterns were described, with reference to a U-shaped test-piece. Table 1 was presented to indicate the improvements effected by better control, mainly of temperature and injection pressure.

TABLE 1.—*Dimensional Variations Attained in U-shaped Test-pieces Before and After Improvement of Technical Control.*

Wall thickness, mm.	"Free" Shrinkage (along axis), mm.		Restricted Shrinkage (around inner surface of U), mm.	
	Before.	After.	Before.	After.
1–2	0.2	0.1	0.15	0.08
2–5	0.4	0.15	0.3	0.12
5–10	0.6	0.25	0.5	0.2

The relevant factors were found to be poor thermal-conductivity of waxes; very high liquid-shrinkage; solid contraction (always less than liquid shrinkage); mode of solidification—whether pronounced crystalline structure or not; injection pressure.

European Investment Casters' Conference

Selling Investment Castings

By J. Zwerner (Durox, Geneva)

In this paper—which was presented, in the author's absence by M. Denain—a number of examples were given of investment casting having replaced other methods of production. In some cases, the initial cost of the investment castings had been higher than components manufactured by other means, but this had been offset by savings in assembly operations, or machining, or by improved performance in service.

Dies for Investment Castings Patterns

By E. Hengler (Carp and Hones, Düsseldorf)

An account was given of the techniques employed in the production of dies using soft metals. machined steel, metal spraying, rubber, plastics and the electro-erosion techniques. Cost comparisons were made in terms of the capital equipment required and the service life of the pattern. It was shown that design factors, length of production-run and accuracy required, had an over-riding influence on the choice of method, but for casting quantities below 1,000 off, the order of choice would be: first, soft metal; second, sprayed steel; and third, machined steel—the last being about four times the cost of spraying. When quantities in excess of 5,000 were required, soft-metal dies were unsuitable because of wear, and when quantities in excess of 10,000 were specified, sprayed-steel dies might be eliminated from consideration if close tolerances had to be held and if the design included much coring.

Ethyl Silicate as a Binder for Refractory Materials*

By J. Evans (Monsanto Chemicals, Ltd.)

In the absence of the author of this paper, by J. Evans (Monsanto Chemicals, Limited), was presented by Mr. N. L. G. Thomas. It showed that ethyl silicate and silica sols were now well established as satisfactory binders for refractories and investments, but that waste could occur if carefully planned formulations were not properly understood. Various hydrolysis and gelation techniques were described to show the versatility of the materials and to indicate how, by small adjustments, considerable improvement in properties could be secured. It was suggested that a better understanding of the large range of possible formulations might suggest new applications for these materials.

Art-founding of Cast-iron, in the 19th and 20th Centuries

By (Miss) Dr. S. Theisen

Since the beginning of the 19th century cast-iron has been used more and more in constructional designs, and also for casting statues and objects of art. Before that time ornamental cast-iron had been used mainly for oven plates only. The first example of art work was an ornamental cast-iron tombstone for the Count of Einsiedel. This job opened a wide field of application for the lost-wax process. In constructional work several bridges and buildings were made, *e.g.*, the cupola of the Corn Exchange in Paris. In smaller work many castings for ornamental work, and even jewellery (Geiss from Offenbach, who lived in Berlin) were made. Next came the development of round and oval medals bearing the portraits of well-known personalities. In the second half of the century there was a decline in the art as many cheap ornaments came on the market. Nevertheless, cast-iron might well be an appropriate material for modern artists, for example Matares' animal figures or some of Moore's works of art.

Closing Session

The Conference was formally closed by the president at midday on June 3, Mr. Meerkamp van Embden paying tribute to all those who had contributed to its success. A vote of thanks to the president was proposed by Mr. John Bolton.

In the afternoon of that day a visit was made by a number of congress delegates and their wives to the Krupp Research Laboratories and to the Villa Hügel—the former home of the Krupp family and now a museum.

* This paper, also, had been previously presented to the BICTA Conference in London and is shortly to be printed in this JOURNAL.

Iron-ore Imports

IMPORTS of iron ore and concentrates (except chrome iron ore and roasted iron pyrites) in July, and the totals for the first seven months of this year and last, are shown in the table below. The figures for 1959 are not completely comparable with those for 1958.

From	Month ended July 31.	Seven months ended July 31.	
	1959.	1958.	1959.
	Tons.	Tons.	Tons.
Sierra Leone	102,000	449,979	387,746
Canada	409,872	1,130,251	985,229
Other Commonwealth countries and Eire	1,446	2,397	9,600
Sweden	323,102	2,035,807	1,703,943
Norway	25,003	185,273	155,998
France	41,919	310,410	270,590
Portugal	14,390	82,117	126,234
Spain	42,737	414,150	298,261
Algeria	95,634	946,916	848,217
French West Africa	15,797	266,069	133,341
Tunisia	33,025	381,878	308,403
Morocco (including Tangier)	32,075	350,443	230,328
Liberia	36,060	196,745	213,573
Venezuela	49,365	972,154	680,448
Brazil	50,958	346,826	315,128
Other foreign countries	21,334	168,225	99,698
TOTAL	1,294,717	8,239,640	6,766,737

A SHIPMENT of a gas-making plant recently left Stockton-on-Tees for Rostock, eastern Germany. Manufactured by the Power Gas Corporation, Limited, it was the first plant to be shipped direct from Stockton to an Iron Curtain country.

Section devoted to the technology of producing
DIMENSIONALLY ACCURATE CASTINGS

Silica Binders for Investment Casting*

By J. I. Evans, M.Sc., A.R.I.C.

Each of the stages of the investment-casting process has its own technology and specialists. This article deals with the binders that are used in mould manufacture, each of which has its own advantages and disadvantages. An appreciation of the chemical background is often helpful to the user, and it is proposed to outline that of the silica binders, particularly ethyl silicate and silica sol—theory is related to practice, and suggestions are made for the close control of the various processes.

The modern version of the "lost-wax" process, now better known as investment casting, has developed during the last fifteen years. There is evidence that a lost-wax process was used by the Early Egyptians, and during the Shang Dynasty in China. Its subsequent progress is not clear, but in the sixteenth century the sculptor, Benvenuto Cellini, cast figures in bronze, silver and gold using a lost-wax process. At the beginning of this century it was again re-discovered as a method for making dental fillings and inlays; contributions to its development have also been made by the jewellery trade.

INVESTMENT-CASTING PROCESS

The first application of the process in recent years is often quoted as the production of turbine blades or buckets for the superchargers of the Flying Fortress aircraft. Turbine blades for jet engines followed naturally from this, the process being ideally suited for the large-scale production of awkwardly-contoured shapes in tough, heat-resistant alloys. To-day, investment casting has become accepted as a versatile metal-forming technique which enables design staffs to develop dynamically-preferred shapes without considering machine shop practicability; expensive assemblies previously welded from several components can be consolidated into a single integral part, and intricate cored passages, cores, lids, etc., may readily be incorporated.

Various Applications

Reduced to its barest essentials the investment-casting process consists of making a disposable pattern, surrounding this with a refractory powder (which is subsequently bonded into a solid mass), removing the pattern, and then pouring the metal into the resulting cavity. Each of these different stages has its own technology and specialists. It is the purpose of this paper to deal only with the binders that are used in mould manufacture. There are many: Plaster of Paris, magnesium phosphate, sodium silicate, silica sol, and ethyl silicate. All find application, each has its own advantages and disadvantages. An appreciation of the chemical background of these binders is often helpful to the user, and it is proposed to outline that of the silica binders, particularly ethyl silicate and silica sol; the theory is related to practical applications, and suggestions are made whereby close control is possible of the various processes involved in their use.

Ideal Binder Properties

The properties of the ideal binder for investment casting may be summarized as follows:

(*a*) It must not contribute any contaminants that lower the refractoriness of the mould, and it must be completely inert at the operating temperatures.

(*b*) The slurry of filler and binder must be sufficiently fluid to allow efficient packing around the pattern.

(*c*) The slurry should set within a controllable time to give a mould of high green-strength.

Ethyl silicate and silica sol meet these requirements, both being a convenient source of silica in a form suitable for binding refractory shapes and moulds. Although the details of the process used with each are different, the underlying concepts are similar and may conveniently be dealt with together.

Chemical Processes Involved

Ethyl Silicate

The esters of ortho silicic acid $Si(OH)_4$ were first studied by Pellini[1], although they were first prepared by J. A. Ebelman in 1846. The acid has been isolated only at low concentrations, and the esters are usually prepared by reaction of the appropriate alcohol with silicon halide. Ethyl orthosilicate is

* Paper presented at the first annual conference of the British Investment Casters' Technical Association, which was held at Connaught Rooms, London, on May 11 and 12. The Author is on the staff of Monsanto Chemicals, Limited, of Fulmer, Bucks.

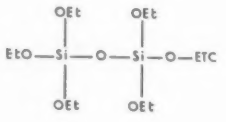
Silica Binders for Investment Casting

formed by the reaction between silicon tetrachloride and ethyl alcohol:

$$SiCl_4 + 4C_2H_5OH \rightarrow (C_2H_5O)_4Si + 4HCl$$

Ethyl orthosilicate is also referred to as tetraethoxy silane, tetraethyl orthosilicate, or more simply as ethyl silicate. It has a silica content of 28 per cent.

If the alcohol contains water, then some hydrolysis of the ethoxyl groups to hydroxyl groups occurs, with subsequent condensation giving polymers of the following general configuration:



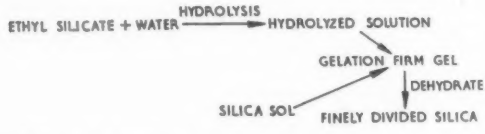
The silica content of condensed ethyl silicate is about 40 per cent., and for this reason an ester of this type is preferred in many applications; it is available commercially as Silester O. The applications of condensed ethyl silicate depend upon its hydrolysis to polysilicic acids, with subsequent gelation and dehydration to hard insoluble silica. The hydrolysis is slow in neutral solution, but is catalyzed by both acid and base.

Silica Sol

In the silica sol the silica is present as small particles of colloidal dimensions suspended in water. Recent improvements in manufacturing techniques have enabled sols to be made with silica contents up to 30 per cent. Silica sols are available commercially as Syton C and Syton 2X, which have silica contents of 15 and 30 per cent. respectively. The silica particles in Syton 2X are smaller than those of Syton C; both sols have excellent storage stabilities. These sols resemble in some respects the acid hydrolysed solutions of ethyl silicate and, with the exception of the hydrolysis stage, the sequence of operations is essentially the same for each.

Sequence of Operations

The various stages may be summarized as follows:—



The additional step to hydrolyze the ester is therefore considered separately.

HYDROLYSIS

The hydrolysis of ethyl silicate involves the conversion of the ethoxyl groups to hydroxyl groups by reaction with water:

$$Si(OC_2H_5)_4 + 4H_2O \rightarrow Si(OH)_4 + 4C_2H_5OH$$

In neutral solution the hydrolysis proceeds very slowly, but is accelerated under both acid and alkaline conditions. Acid hydrolyzed solutions in general are relatively stable, but may be gelled by neutralizing their acidity; alkaline hydrolysis yields solutions that gel spontaneously without further addition. Both types of hydrolysis are used in refractories technology, but the alkaline hydrolysis/gelation is conveniently treated in the section following that on gelation of acid hydrolyzed solution.

The acid catalyst normally employed is commercial concentrated hydrochloric acid (S.G. 1.180) at a concentration of 0.05-0.5 per cent. vol./vol. on the final solution. Because ethyl silicate is immiscible with water, the hydrolysis is usually carried out in a mutual solvent such as ethyl alcohol or isopropyl alcohol; their binary water-azeotropes, which are cheaper, are also suitable provided due allowance is made for the water already present in the alcohol.

The miscibility curves of the ternary systems ethyl silicate/alcohol/water are given in Fig. 1. To the left of the curves lines AX_1, AX_2, AX_3 the mixtures are homogeneous; to the right separation occurs initially, but miscibility tends to be restored as the reaction proceeds with formation of ethyl alcohol and the conversion of the ester to polysilicic acids.

The hydrolysis is accompanied by a rise in temperature, the magnitude of which will depend upon the volume and surface area of the vessel, the rate of stirring, evaporation rate, etc. It is preferable to allow the hydrolyzed solution to stand overnight before use. Typical hydrolysis formulations are set out in Table 1. These are all based on the theoretical minimum water requirement for complete hydrolysis, *viz.* 15 per cent. vol./vol. of ethyl silicate.

TABLE 1.—*Typical Hydrolysis Formulations.*

	Parts by volume.					
I.M.S. 64 O.P. SG 0.818	63.4	48.9	34.4	—	—	—
I.P.S.2 SG 0.815 ..	—	—	—	65.0	53.0	38.0
Water	1.6	4.1	6.8	—	—	3.1
Silester O	35.0	47.0	58.9	35.0	47.0	58.9
Per cent silica (approx.)	15	20	25	15	20	25

Stability

The storage stability of these hydrolyzed solutions is dependent upon a number of factors; maximum stability is achieved under the following conditions:

(*a*) Low temperature; by lowering the temperature from 30 to 5 deg. C. the period of storage may be increased ten times; intermediate temperatures increase the life correspondingly.

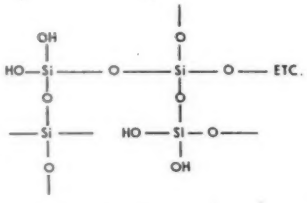
(*b*) Acid concentrations within the range 0.05 to 0.5 per cent. are preferable; at lower concentrations silica tends slowly to settle out of solution, while high acid concentration causes premature gelation of the entire solution.

(*c*) Low water, high alcohol and low silica contents all enhance storage stability; these factors are usually fixed during preparation, but judicious

selection of the various combinations may allow a final adjustment before use, *e.g.* initial water concentration may be kept low, extra water being added later.

Molecular Structure after Hydrolysis

During hydrolysis the ethoxyl groups of the silicate will have been hydrolyzed to hydroxyl groups, resulting in large polysilicic acid molecules, some of highly-branched structures with a degree of cross-linking, a simple molecule being represented as:—



These hydrolyzed solutions bear some resemblance to the silica sol in which the hydrated silica is present as small particles. According to Carman[2] the silicon atom attempts to retain the tetrahedral configuration, with the result that the surface of the silica particle is heavily hydrated, and may be represented as shown in Fig. 2. There is an obvious similarity between this concept of the silica particle and that of the large molecule of polysilicic acid. The formula of the silica particle may be written $(SiO_2)x(H_2O)y$, and it may be shown[3] that for a particle 10 millimicrons in diameter $x=11{,}500$ and $y=1{,}240$. For a smaller particle 1 millimicron in diameter—invisible even in the electron microscope—x becomes 11.5 and $y=12.4$. The composition of the silica particle then approaches that of polysilicic acid $(SiO_2.H_2O)n$. There is therefore a strong similarity between a hydrolyzed solution and a silica sol, and the mechanism of the subsequent gelation stage is essentially the same.

GELATION

In both cases the binder solution, either hydrolysed ethyl silicate or silica sol, is mixed with the refractory filler, the resulting slurry being poured around the pattern and allowed to set. This solidified version of the silica sol or hydrolyzed solution is called a gel; the transformation to this form can take anything from a few minutes to several months or even years. Hurd[4] has sumarized the various theories which have been advanced to explain the formation and structure of silica gels. These include the emulsion theory, the cellular theory and the fibrillar theory; because of the wide variety of silica gel structures that may be formed it is quite likely that silica gels can be found which conform to any one of these theories. There seems little doubt that silica gels can result from the linking-up of molecules of polysilicic acid, or by aggregation of silica particles of colloidal size. This is further justification for considering together the gelation of both the silica sol and the hydrolyzed solutions of ethyl silicate.

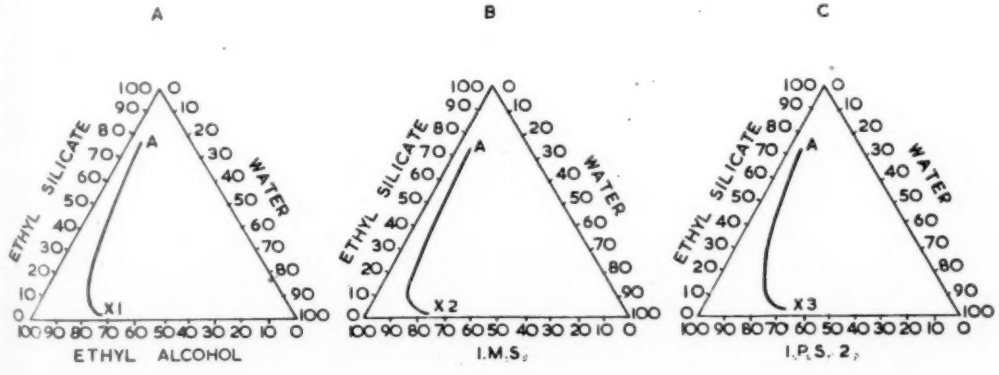
Rate of Gelation

The rate of gelation of these silica systems depends upon a number of factors, but the most important for the present purpose is pH. The general relationship between the logarithm of the gelation time and pH is shown in Fig. 3 (*a*). Maximum stability or longest time to gel occurs at a pH between 1.5 and 2.0; gelling is most rapid at pH 5-6. Below about 1.5 the stability decreases again, while above pH 6 it increases again up to a pH of about 11. These are, of course, general trends, the actual gelation time of any solution depending upon other factors as well.

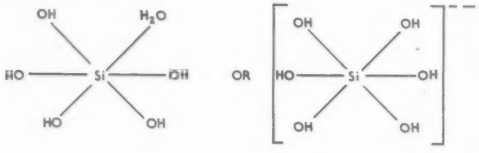
Various Theories

Several explanations have been advanced for this behaviour and these have been reviewed by Iler[5]. Flemming[5] first demonstrated that the gelling of silicic acid is catalyzed by both H^+ and OH^- ions. To account for this, Iler[6] suggested that below pH 1.5 the reaction rate is catalyzed by the fluoride

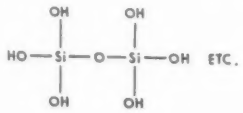
FIG. 1.—*Miscibility curves of ethyl silicate and water with* (*a*) *ethyl alcohol,* (*b*) *I.M.S., and* (*c*) *I.P.S.2.*



ion F^-; traces of fluoride impurity are almost invariably associated with silica. The fluoride ion is similar in size to the hydroxyl ion OH^-, which catalyses the reaction above pH 1.5. Thus, as the pH rises above this value, the OH^- ion concentration increases, and the rate of gel formation increases accordingly. In the presence of the OH^- ion the co-ordination number of silicon, it is suggested, rises from 4 to 6, resulting in configurations which have been written as:



This highly reactive intermediary will then combine with another similar molecule or with $Si(OH)_4$ to give:



—The silicon atom can also increase its co-ordination number to 6 when combined with the F^- ion, which is similar in size to the OH^- ion. A rise in pH corresponds to an increase in OH^- concentration, the rate of gelation thus becoming more rapid up to pH 5 to 6; above this the OH^- ion concentration has increased to the extent where OH^- ions begin to be adsorbed by the molecules or particles; the negative charge reduces the number of collisions and the rate of gel formation decreases again.

Gelling the Different Binders

The solutions formed by acid hydrolysis of ethyl silicate lie on the peak of the graph at about pH 1-2; the silica sols on the other hand are on the alkaline side of neutrality, and owe their stability to the negative charge on the particles. The adjustments necessary to gel the two types of binder solution are therefore rather different. With the hydrolyzed solutions the pH must be raised to the unstable region where the OH^- ions catalyze the rate of gelation. The silica sols may be gelled either by reducing their pH to the same region or by adding a solution containing positively-charged ions. By neutralizing the charge of the particles such a solution causes extremely rapid gelation, although the actual speed will depend upon the number of positive charges carried by the cations and by the concentration of the solution; adjustment of the pH of the sol does not cause immediate gelation. The practical application of these principles is quite straightforward, although the actual gelation accelerators for the hydrolyzed solutions will be different from those for the sol.

Filler Alkalinity

After preparation the hydrolyzed solution is mixed with the refractory filler, the selection of which will have an important bearing on the properties of the final mould. Each foundry has its own preferences for filler type and grading, and the subject is outside the scope of the present discussion; filler alkalinity is the only property which is of interest, and this will have some bearing on the behaviour of the investment slurry. The reason for this is that the hydrolyzed solution is caused to set by neutralizing its acidity, thus increasing the pH to the unstable region. The filler is not normally sufficiently alkaline, and the practice has been to add finely-divided magnesium oxide during the blending process. Although insoluble, the magnesium oxide gradually neutralizes the hydrochloric acid, and the entire mould finally sets to a firm, rubbery consistency. This method is quite effective, but control of gelation time is not possible by control of rate of magnesium oxide addition. This is illustrated in Table 2. The second and third columns of Table 2 record the gel times of a filler/binder mix at two levels of magnesium oxide concentration. There is little significant difference between the two. This table does illustrate, however, a method whereby gel time can be controlled; the left-hand column speci-

TABLE 2.—*Gel Times with Magnesium Oxide as Accelerator.*

Percentage water added to solution.	Gel times (min.)	
	0.5 per cent MgO.	1.0 per cent MgO.
0.0	120	120
1.0	75	65
2.0	50	40
5.0	25	25
7.5	14	12
10.0	10	8

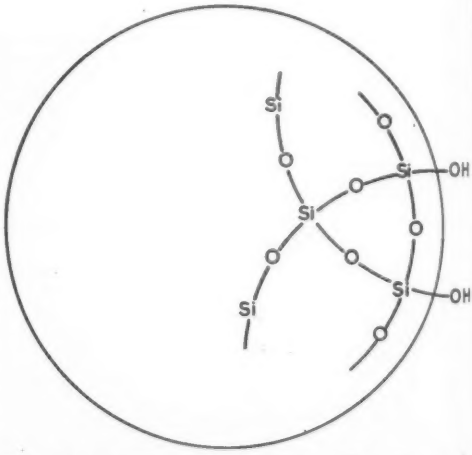


FIG. 2.—*Representation of the tendency of the silicon atom to retain a tetrahedral configuration.*

fies the extra water added to the hydrolyzed solution immediately before mixing with the filler; this water is in excess of that required for complete hydrolysis, *i.e.* 15 per cent. vol./vol., and the gel times of the mixtures decrease with additional water.

Magnesium Oxide Addition

The reason that control of the magnesium oxide addition is ineffective in controlling gel time is readily seen by examination of the titration curve of magnesium oxide against an N/10 solution of hydrochloric acid (Fig. 3 (*b*))—strong base against strong acid. The pH changes rapidly between about 2 and 8 for very small changes in the magnesium oxide concentration; Fig. 3 (*a*) demonstrates clearly that gel time is controllable by pH only within the range 4-6. With magnesium oxide as accelerator it is obvious that, provided the concentration is greater than the minimum for neutralization, then the actual excess has no effect on gelation time. If, however, a weaker base than magnesium oxide is used for the neutralization, the pH at the neutralization point will not be as high and the gelation less rapid. By the addition of a further quantity of a base of suitable strength, it is possible even to vary the time of gelation with the amount of base added.

Effects of Base Additions

To explain this, consideration must be given to the solution after complete neutralization by a weak base of the free hydrochloric acid used for hydrolysis. Further addition of the base establishes an equilibrium between free base and its salt (chloride); this state is exactly similar to that of a base being neutralized by an acid. A plot of pH against acid added gives an S-shaped curve usually referred to as a titration curve; this is defined by:

$$pH = pKa - \log \frac{[salt]}{[base]}$$

where pKa is the logarithm of the reciprocal of the dissociation constant of the base, and [salt] and [base] are the concentrations of salt and free base respectively. It should be appreciated that the first term refers to the strength of the base employed, and determines the position of the curve on the pH scale. The second term shows the manner in which the pH is affected by increasing the added acid, and shows that the relationship between added base and pH, and therefore gel time, is a logarithmic one.

Experimental Titration Curves

The above theory strictly speaking applies to aqueous solutions of moderate concentration; to obtain data in keeping with the application under investigation practical experiments were carried out. The following comments apply more correctly to this experimental data. Practical examples of these titration curves are shown in Fig. 3 (*c*), which shows curves for the bases pyridine (pKa = 5.3), triethanolamine (pKa = 7.8) and piperidine pKa = 11.1). The position of the comparatively flat portion of each curve is determined by the pKa of the base; it is on this section that the pH of the solution may be adjusted by varying the amount of added base. The practical implication of these curves is that, by suitable choice of base, it is possible to vary the pH, and hence the gel time, of an acid hydrolyzed solution within the required range. This is illustrated in Table 3; the first column gives the percentage vol./vol. of a 6 N pyridine solution which was added to an acid hydrolyzed solution of ethyl silicate, with the resulting pH and gel time given in the second and third column respectively.

TABLE 3.—*Gel Times with Pyridine as Accelerator.*

Percentage vol./vol. of 6N pyridine.	pH.	Gel time (min.).
0.68	3.0	4 days
1.6	4.0	15 hr.
8.0	5.0	90 ,,
10.0	5.2	50 ,,
12.0	5.4	40 ,,
14.0	5.6	35 ,,
18.0	5.8	28 ,,
26.0	6.0	26 ,,

The actual gel time will, of course, depend on other factors such as silica concentration, ambient temperature, etc., but this table does demonstrate that a measure of control is possible which could not be achieved with an incorrectly selected base.

FIG. 3 (*a*).—*Graph showing the influence of pH on the gelation time of silica systems.*

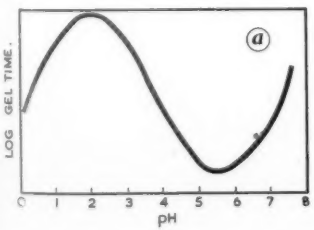


FIG. 3 (*b*).—*Graph showing the effect of magnesium oxide on a standard acid solution.*

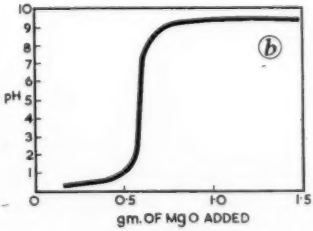
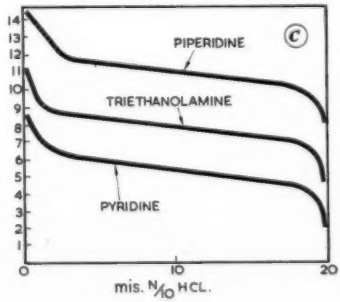


FIG. 3 (*c*).—*Graph showing the effect of acid addition on the pH of standard amine solutions.*



Silica Binders for Investment Casting

Effect of Age on Solutions

The effect of age on solutions of 15, 20 and 25 per cent. silica content is shown in Table 4; after 10 days ageing, the gelation times had decreased by about 20 per cent., which, although significant, should not prove a serious embarrassment to the investment foundry. These small changes with age can be compensated by an appropriate reduction in the quantity of accelerator, *e.g.*, with the 25 per cent. solution a gel time of 65 min. can be maintained over 10 days by successively reducing the pyridine addition from 10 to 6 per cent. Such adjustments in gelation time are not possible with

TABLE 4.—*Variation of Gel Time with Age and Silica Content of Solutions.*

Percentage vol./vol. of 6 N pyridine.	Age (days).	Gel time (min.).		
		15 per cent SiO_2.	20 per cent SiO_2.	25 per cent SiO_2.
6	1	270	165	100
6	6	245	150	80
6	10	235	135	70
8	1	215	140	85
8	6	190	120	65
8	10	185	110	55
10	1	185	125	65
10	6	170	100	50
10	10	160	95	50

the usual strongly-alkaline accelerators. Table 4 also shows the effect of increasing silica content on the behaviour of the hydrolyzed solutions; as would be expected, the solutions become progressively less stable as the silica content increases, consequently requiring less accelerator to achieve comparable gel times. Again, the use of a weak base as accelerator enables compensatory changes to be made.

Effect of Various Amine Accelerators

That the other bases besides pyridine, *viz.* piperidine and triethanolamine, do not quite meet the requirements is illustrated by Table 5. In this case normal solutions of each amine were added to a hydrolyzed solution at three concentrations.

TABLE 5.—*Gel Times with Different Amines as Accelerator.*

Amine.	Gel time at various rates of addition		
	2 per cent.	4 per cent.	6 per cent.
Piperidine	10 min.	3 min.	1¼ min.
Triethanolamine ..	80 min.	12 min.	6 min.
Pyridine	36 hr.	>3 hr. <15¼ hr.	>3 hr. <15 hr.

The decreasing gel time as the pKa decreases is clearly illustrated at each concentration; the rapid change in gel time with concentration of the stronger bases is also evident.

Addition of Electrolyte

This method of gelation control is not applicable to the silica sols, which are situated on a different portion of the stability curve. They are prepared at pH 10 and their stability is reduced by lowering the pH; alone, this is not sufficient to produce a gel within a practicable time. Even at neutrality gelation can take up to 20 hr. Addition of electrolyte is more effective; the charges on the particles are neutralized and rapid gelation occurs. By lowering the pH of the sols it might be expected that they would become less sensitive to electrolyte addition. That this is so is illustrated in Table 6, in which the effect is seen of adding a fixed quantity of electrolyte solution to sols of different pH's.

TABLE 6.—*Influence of pH on Gel Time with Added Electrolyte.*

pH of sol.	Effect of electrolyte addition.
10.0	Immediate gel
8.2	2 min. to gel
6.1	72 min. to gel
4.1	2 days to gel
2.2	No gel

At pH 2.2 the sol has passed through the minimum stability region and is completely insensitive to electrolyte addition, its stability depending upon the absence of OH^- ions as catalyst rather than on mutual repulsion of particles.

Applications of Silica Sols

These properties provide the basis for the several applications of silica sols, both for investment casting and in other fields[7]. In one patent[8] silica sol is specified as the only binder for the investment; gelation is effected by calcium chloride, calcium carbonate, magnesium oxide, or magnesium carbonate at concentrations of 0.01 to 1 per cent. of the entire mix. Silica sol is also used with acidified sodium silicate in the manufacture of moulds with intricate, internal contours[9]. Considerable strength is required of such moulds, and the addition of silica sol enables this to be achieved without increasing the percentage of sodium.

Dip-coats

The sols are also used in the pre-coating slurries or dip-coats for the wax patterns. A very finely divided refractory is used as filler, and the chief requirement of the slurry is stability—the slurry should not gel, neither should the refractory settle out of suspension. No accelerator is necessary, and suspension is maintained by suitable choice of wetting agent. Ethyl silicate may also be used in dip coats, the essenial feature being stability and freedom from gelation. Again, pH control is important, although in this application a figure of 1.5-2.0 should be maintained. If the dip-coat bath is in continuous use, with intermittent topping up, it is important to maintain the acidity by addition of dilute hydrochloric acid at intervals. Residual alkalinity in the filler could easily cause a gradual drift upward of the pH, resulting in gelation of the whole bath, which is obviously most undesirable.

ALKALINE HYDROLYSIS GELATION

Hydrolysis will also occur under alkaline conditions, as already explained. The resulting solutions are unstable, and gel spontaneously within a comparatively short time of preparation. In certain

applications this technique has advantages, notably that of simplicity, one operation being required instead of two. The alkaline hydrolysis catalyst is usually an organic amine, although certain metal amides are also effective. The amine is mixed with the ethyl silicate, at a pre-determined concentration, to give a solution which will hydrolyze and gel on adition of aqueous alcohol[10, 11]. Until such addition is made the amine-modified ethyl silicate is quite stable and may be stored for many months, provided that damp air is excluded.

Choice of Amine

The actual choice of amine is important, because not all are sufficiently alkaline to cause the hydrolysis to go rapidly to completion. Piperidine and dicyclohexylamine, either alone or in combination, have been found suitable, the concentration used depending upon the gel time required. The latter is controlled also by the aqueous alcohol; it is often convenient to make the amine modification in bulk, thus pre-determining to some extent the subsequent gelation time of the ethyl silicate. Further small modifications may be made by varying the aqueous alcohol concentration. Table 7 illustrates the variations in gel time that may be obtained by control of amine concentration, or by the proportion of aqueous alcohol.

TABLE 7.—*Gel Time of Amine-modified Ethyl Silicate.*

Percentage piperidine.	Percentage alcohol/ water mixture	Gel time (min.)
1.0	15	25
	20	20
	25	18
1.5	15	12
	20	8
	25	7
2.0	15	8
	20	5
	25	4¼

This method[12] of using ethyl silicate has been successful in the manufacture of refractory objects such as sagger-boxes and small furnace linings, and for precision piece moulds.

CONCLUSIONS

Ethyl silicate and silica sols are now well established as excellent binders, both for refractories and investment moulds; in many cases, however, the rule-of-thumb prevails over carefully planned formulations, resulting in an unnecessary waste of expensive materials, and lack of operational control. It is hoped that the suggested hydrolysis and gelation techniques are sufficient to demonstrate the versatility of these materials, and to show that even small adjustments to an established process may effect considerable improvement. Furthermore, a better understanding of the large range of possible formulations may suggest opportunity for the use of ethyl silicate or silica sols where previously they had been thought unsuitable on functional or economic grounds.

Acknowledgments

The author wishes to thank the management and directors of Monsanto Chemicals, Limited, for permission to publish this paper, and to acknowledge with gratitude many helpful discussions with Dr. E. J. Shepherd.

REFERENCES

[1] Pellini, G., *Gazz. chim. ital.*, 1915, **45**, 380–385.
[2] Carman, P. C., *Trans.* Faraday Society, 1940, **36**, 964–973.
[3] Iler, R. K., "The Colloid Chemistry of Silica and Silicates," Cornel University Press, New York, 1955.
[4] Hurd, C. B., *Chem. Rev.*, 1938, **22**, 403–422.
[5] Flemming, W., *Z. Physik Chem.*, 1902, **41**, 427–457.
[6] Iler, R. K., *J. Phys. Chem.*, 1952, **56**, 680–683.
[7] Emblem, H. G., Meadowcroft, A. E., and Stockwell, G. E., *Metallurgia*, 1950, **41**, 157.
[8] U.S.P. 2,380,945.
[9] Cloherty, D. J., and Emblem, H. G., *Industrial Chemist*, March, 1955.
[10] B.P. 575,752.
[11] B.P. 612,622.
[12] Scott, H. F., and Emblem, H. G., *Refractories Journal* 1951, **27**.

DISCUSSION

The CHAIRMAN (Mr. W. Foyers, of H. & F. Precise Castings, Limited), thanked Mr. J. I. Evans for his paper, and then called upon Mr. Leadbetter to open the discussion.

MR. LEADBETTER (H. & F. Precise Castings, Limited), said Mr. Evans had mentioned certain accelerators and the optimum water contents necessary to produce a gel. Was there a range of these additions and water contents which could produce optimum gel strength? In view of the price of ethyl silicate, the best possible use had to be made of it. Also, what was the difference in the gel structure between the gel produced by a silica sol and the ethyl silicate?

MR. EVANS replied that it was not possible to specify conditions for optimum gel-strength without first defining the term. What exactly was it that the investment caster regarded as optimum? The difference between the gel structure of ethyl silicate and that of silica sol was possibly attributable to the method of formation. Ethyl silicate started off with large molecules which grew and resulted in a large tangled molecule, whereas in the silica sols, the particles were larger than the molecules and simply agglomerated, only joining where they touched.

MR. LEADBETTER added that he would have liked more information on gel strength because it was very important to the industry. Investment casters wanted a certain gel strength in as short a time as possible to give a mould that would withstand handling. At the same time, they required a sufficient silicate content to bind the particles. He knew from his experiments with ethyl silicate, that even with a constant silica content, gels of varying strength resulted. For instance, by using a very long gelling time, the gel produced eventually seemed to be weaker than one using the same silica content and a rapid gelling time. Mr. Evans had said that a certain definite amount of water was essential for complete gelation and he assumed that below and above that figure a weaker gel was obtained.

American Work

MR. EVANS, in a further reply, said much work had been done in the USA on minimum water contents for complete hydrolysis, using tetrethyl-orthosilicate; *i.e.*, the straightforward monomer. The work was therefore simplified; with ethyl silicate, there was a mixture of molecules, containing one or more silicon atoms. If one assumed an average chain length of five silicon atoms, a figure of 15 per cent. water for complete hydrolysis could be calculated.

A useful method of discovering whether hydrolysis had taken place was to flow out the solution on to a glass plate and allow it to dry. If it had not hydrolyzed it remained sticky; if it had hydrolyzed,

then the solution dried off and a fine white powder resulted, which was silica. Above the minimum water content, the silica concentration decreased and the gel got weaker.

Presumably, said MR. LEADBETTER, the methylated spirit content could be reduced and the silica content kept the same.

Then, one returned to the definition of optimum gel-strength. MR. EVANS said the higher silica content, the stronger the gel; probably, the faster the gel time, the stronger the gel; with a very long gel time, drying out, rather than gelation, took place, and the structure was not as strong as if it had gelled and then dried out. It was difficult to determine in the laboratory exactly what strength of mould was required to give ideal properties, simply because these would depend on the shape, size, etc., of the mould.

Possibility of Heat Gelation

MR. A. DUNLOP (W. J. Hooker, Limited), said: reference has been made to acid-hydrolyzed solutions and the use of basic materials, such as magnesia, to control the gel. These were expensive materials and it was necessary to use them to the best advantage. There was another method of gelling, namely by the application of heat. It was possible to have a hydrolyzed solution which was quite stable, to invest the mould, consolidate by vibrating and pour off the slurry, and use it again in another mould. Then the mould was gelled by raising the temperature; he would like to have the lecturer's comments on that.

Regarding alkaline hydrolysis, reference had been made to the fact that pyridine might be added to the ethyl-silicate bulk. Then, the gel time was controlled by the amount of water added. Could the silica content be controlled by the addition of some non-aqueous solution? Was it always necessary to use the ethyl silicate at full strength—getting back to the question of cost. Could it be diluted, but not with "wet" alcohol; what liquid would Mr. Evans suggest as a diluent which would not affect the gel time?

MR. EVANS reported that he had no figures relating to heat gelation. Raising the temperature of the mould was an accepted method of causing gelation; it had the advantage that, when using a very wet slurry, the excess could be re-used; with an alkaline accelerator this was not possible. Regarding the adding of piperidine as an alkaline gelation, or alkaline hydrolysis-and-gelation-accelerator, the only method of lowering the silica content was to put in more alcohol as a diluent. It would require a certain amount of experimental work which was quite easy if done with straightforward solutions. For example, it could be done with very small quantities in test tubes—with 10 or 12 ml. of solution.

MR. DUNLOP said this must be done with water-free alcohol; it could not be done with methylated spirit, for instance, because more water was then added. The question was, how would the speaker dilute the silica content without affecting the gel time. Would he use wet alcohol for controlling the gel?

Gel time was best controlled by attention to the piperidine concentration, replied MR. EVANS. The silica content could, therefore, be lowered by adding more industrial methylated spirit, reducing the rate of piperidine addition to keep the gel-time constant. A compromise had to be reached on the amount of piperidine added and the amount of water and alcohol. That was one of the difficulties in accumulating this sort of information—there were so many variables which would affect the gel time of ethyl silicate that it was impossible to provide a table—a ready reckoner, as it were—giving all possible conditions which could be encountered. Each user, if he wanted to achieve small variations, would have to do a small amount of experimental work. It was the object of his Paper to indicate the lines which could be followed in order to make small variations in technique.

Mould Strength

MR. G. LYON (Fairey Aviation Ltd.) said the mould must be considered as an engineering structure and it was of interest to know its strength against the loads which it was called upon to bear. One of the primary factors in this would appear to be the tensile strength of the binder. If members could be informed of the range of tensile strength after firing, of the material shown by Mr. Evans in his test-tubes, it would be possible to indicate whether it was adequate.

MR. HOPE, replying, said that on the question of mould strength, when setting the moulds by using heat, the essential was that the mould acquired natural strength just by being wetted by a liquid, and did compact down into a very dense mould, having a high strength. Therefore, it was possible to put that mould into an oven and to set it off, and, at the same time, melt the wax patterns without the mould collapsing. When using a heat-setting technique, it was necessary to have a filler with an optimum packing property, for example, one containing a fine fraction of dense material, such as zircon.

Mr. Lyon had raised some further points about taking a typical hydrolyzed solution, mixing it with a round-particle-size silica sand in a certain proportion and vibrating the wet mix into the mould. Such a slurry would give an extremely low strength. If that same solution were mixed with a filler having an optimum packing property, then it would set into a very strong mould. Therefore, the question of the gel strength obtained from the hydrolyzed solution was not dependent only on the hydrolyzed solution, but was a function of the hydrolyzed solution and the filler.

MR. LYON thought this reply was not entirely satisfactory, because some fundamental value must be involved. Whereas the effect of keying between the grains of the refractory was appreciated, in some circumstances the strength of the mould depended on the tensile strength of the bond and not on the packing. Tensile failures of moulds were experienced and if investment casters knew more of the physical properties of the binder, *i.e.*, in tensile after the normal processing, it would take them further along the road to preventing burst moulds.

The CHAIRMAN said what Mr. Lyon was in fact referring to was that he would like to be able to make, within close limits, a strong or weak mould, depending on the application.

MR. M. RIDDIHOUGH (Deloro Stellite, Limited) held that possibly there was quite a technique set out already for testing this; also in the concrete industry, where concrete tensile specimens were prepared. One should be able to adapt that procedure under standard conditions to test the strength of investment binders.

On this aspect MR. EVANS replied that the bond-strength of ethyl silicate was best determined by using it to bind a filler and to carry out a tensile test (say) on a standard specimen. The strength depended upon so many factors that figures were meaningless unless related to definite conditions, specimen size, etc.

[This ended discussion of this Paper.]

Fulmer Open Day

Fulmer Research Institute held their annual Open Day recently at Stoke Poges, Bucks. Over 300 visitors attended, including many notable personalities from the spheres of research, metallurgy and metals engineering. The laboratories were open for inspection from 10.30 a.m. onwards, a buffet lunch being served in a marquee from 12.30 to 2 p.m. In the afternoon, the party was addressed by Mr. P. Horsfall (chairman of Almin, Limited—the firm originally responsible for the Fulmer Research Institute project), and afterwards thanks were expressed on behalf of the visitors.

The Institute differs from the usual research associations and Government laboratories in that it receives no annual grant or income, except in payment for services rendered. Since it is entirely free from Government control, no particular section of industry has any rights or priority in research results or facilities, a feature that often appeals to industrial sponsors who have no adequate research facilities themselves, but who wish to keep both their problems and aims confidential.

Tour of Premises

The JOURNAL'S representative started his tour of the laboratories in the main building. Of particular interest was the cathode-ray polarograph on the first floor, and the work in progress on the oxidation of zirconium and zirconium alloys. There is a well-equipped corrosion laboratory on the same floor (containing all the standard corrosion-testing apparatus), and also apparatus for electro-chemical measurements.

Next on the list was the physics laboratory, where the original metallurgical work on age-hardening of aluminium alloys, supervised by Dr. Hardy, is continuing. Trace elements have been shown to exercise a profound effect on the ageing behaviour in some systems, and the influence of small quantities of cadmium in accelerating the ageing of aluminium/copper alloys led to the development of the aluminium/copper/cadmium alloys, which, while free from room-temperature ageing after solution-treatment, can be aged at slightly elevated temperatures to give properties approaching those of the Duralumin-type alloys.

The engineering laboratory is equipped to carry out all normal mechanical tests. In addition to impact and hardness machines, a Dennison 50-ton universal testing machine, with ancillary equipment for high- and low-temperature testing, is in use. Conventional creep-testing apparatus is supplemented by facilities for carrying out creep tests in compression, and in special protective atmospheres. This has proved essential in studies of compression creep of uranium and other highly reactive metals. Special equipment is frequently designed and manufactured here for use in investigations for which standard equipment is not adaptable.

Foundry

The tour concluded with a visit to the foundry, which is equipped with the normal oil- and gas-fired furnaces for melting. Apart from these, induction furnaces have been adapted for melting and casting in special atmospheres or *in vacuo*, and for zone refining as well as for open melting. Most reactive alloys for experimental work are prepared in argon-arc melting furnaces with water-cooled copper hearths. One of these is equipped with a retractable hearth, from which small billets suitable for extrusion can be made. An apparatus has been constructed for melting by electron bombardment, and is used for zone refining and growing single crystals. Work is being done on the development of low-oxygen stainless-steels, and oxidation-resistant low-alloy steels are being developed. There is a large-scale enamelling furnace (see Fig. 1) and spraying unit, and other heat-treatment furnaces.

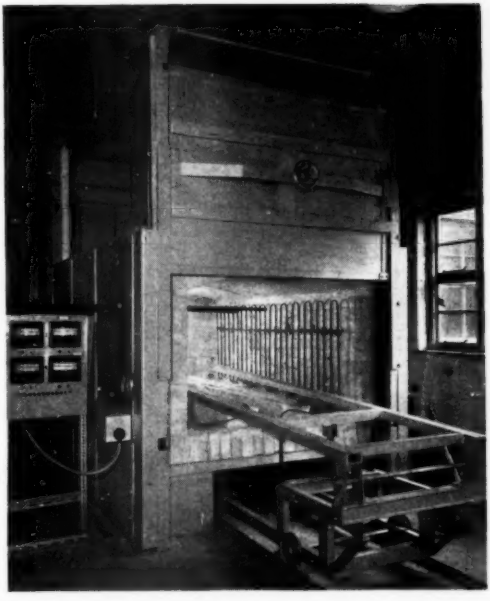


FIG. 1.—*Electric furnace, at Fulmer Research Institute, for firing vitreous-enamelled ware; it is used in connection with the research on vitreous-enamelling of aluminium tubes.*

Chatting with the staff in the foundry section revealed that the automatic spraying equipment developed at Fulmer for vitreous enamelling of aluminium—and in fact the whole project—was carried out for a single sponsor, and concerned the internal coating of formed tubes. An interesting sidelight was the development of a spark technique for detecting pinhole porosity in vitreous enamels. The research had resulted in techniques of enamel application which produced deposits that were completely free from pinhole porosity—the result, it was said, of scrupulous attention to initial metal cleanliness, and the setting up of rigorously controlled procedures to ensure that condition.

Although this building was designated "The Foundry," it held very little resemolance either externally or internally with the general conception held by readers of this JOURNAL. True, there was melting and casting equipment, crucibles and furnaces, but the plethora of vacuum and control devices and ancillary equipment present really converted it into something more akin to a foundry technologist's dream environment.

The list of sponsors of projects at Fulmer includes a number of well-known foundries, and published literature indicates an impressive list of successful achievements in the researches undertaken. Compution of charges is based on the time that staff are engaged on a project, plus materials at cost, and "overheads" at 110 per cent of salaries and wages. The published list of typical charges for routine work ranges from £1 1s. per element for chemical analysis to £500 per annum for the exclusive use of one high-accuracy creep-testing machine.

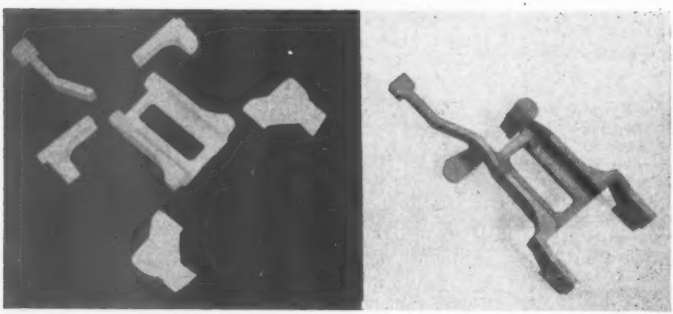
Prototypes from Polystyrene Patterns

Development time for design and alloy selection of investment castings is claimed to be reduced by a technique used by Precision Metal-smiths Incorporated, of Cleveland, Ohio. Metal prototypes of experimental or new parts are investment-cast from patterns of polystyrene. A complex pattern may be formed by breaking it down to its several simple components; each being easily machined from polystyrene, and then assembled with plastic adhesive to the desired design. This technique allows of experimentation with various designs for any given part, which can be cast in several alloys to select the one giving optimum service requirements.

Change of Design Made Easy

Often, several designs of a given part are required in order to determine what is the most functional casting possible. Radical design-changes are not easily effected in the machined-steel die which is normally used to produce patterns for investment castings. Fig. 1 shows an example of the production of an investment-casting for prototype testing of a new part, without tooling. On the left are components of a prototype pattern made from easily-machined polystyrene. These parts may be assembled with plastic adhesive to form the complex pattern. On the right in Fig. 1 is a ferrous investment-casting made from this polystyrene pattern. Radical design-changes may be quickly and economically made merely by re-arranging the components of the pattern.

Fig. 2 shows machined polystyrene components of another prototype pattern. The bottom row (left) gives two views ((*a*) and (*b*)) of assembled plastic components forming two complete patterns. On the right (*c*) is a steel investment-casting made from a similar pattern. The components may be re-arranged in as many different designs as are required for testing of the cast parts. For instance, the four appendages could be placed around the outside diameter in unlimited positions by fastening them on with plastic adhesive. After the design has been accepted a die can then be made to produce patterns for production castings.



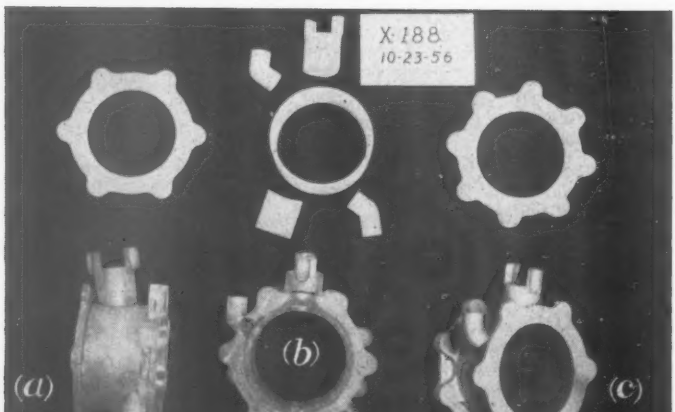


FIG. 1 —(*above*) *Components of a prototype pattern, made from polystyrene, and* (*right*) *a ferrous investment-casting made from the pattern.*

FIG. 2.—(*a*) *and* (*b*) *Two views of plastic components, and the completed pattern, and* (*c*) *a steel investment-casting made from such a pattern.*

National Foundry Apprentices' Competition

To encourage foundry apprentices to take a pride in craftsmanship and to promote amongst them a greater knowledge of foundrywork is the objective of the European Foundry Apprentice Competitions, the first of which was held in Stüttgart in 1957 and the second in Paris in 1958. The third competition is to be held in Great Britain in 1960, and with this in view the Institute of British Foundrymen has undertaken to organize a National Foundry Apprentices' Competition this year, for the purpose of selecting suitable British competitors for the international event.

For the National Competition, competitors must not have attained the age of 20 years on December 31; the contest will consist of a practical test in moulding and coremaking which will last up to eight hours (this test will carry more than half the total marks) and written tests which will comprise: (1) Foundry technology (two hours); (2) calculation (two hours) and (3) drawing (three hours). The latter tests will be held on Friday, November 6, at appropriate local centres which will be arranged by branch Councils of the Institute. The practical tests will be held in suitable regional centres or at a national centre if numbers warrant it.

As a first step, a nomination form, copies of which have been sent to all foundry mangements in the country (further copies can be obtained from the secretary of the Institute) must be completed in respect of each candidate. Nominees should normally have obtained a City and Guilds intermediate (now "ordinary") certificate in foundry practice or an equivalent certificate, or have received suitable technical training. The written tests to be set in the National Competition will be at a similar level to that anticipated in the European Competition.

It is considered that this National Competition can be of the greatest value in stimulating interest in foundry apprenticeship and in raising standards, and the European Competition which is to follow will provide extremely valuable comparative information on the methods of training in this country and in the other countries of Europe. It is therefore urged that every founder in a position to do so, should support the competition by nominating an apprentice on his staff who is, in his opinion, of the required standard.

It should be carefully noted that completed nomination forms should be sent to the secretary of the Institute of British Foundrymen at St. John Street Chambers, Deansgate, Manchester, 3, by October 10.

IBF Headquarters to Return to London

A decision has been made to transfer the head office of the Institute of British Foundrymen to London and the date of the transfer and the new address are expected to be announced quite soon. Some readers may remember that the Institute's headquarters was last in London in 1926, when it was moved to Manchester, following the appointment of Mr. Tom Makemson as the Institute's first full-time secretary. Earlier part-time secretaries were domiciled variously. The first secretary, Mr. F. W. Finch (1904-1907) lived in Gloucester; Mr. J. E. H. Allbut (1907-1913) in Manchester; Mr. A. E. Pilkington (1913-1918) in Chesterfield; Mr. A. Hayes (1918-1920) in London (Mr. Hayes was also Editor of the FOUNDRY TRADE JOURNAL) and Mr. W. G. Hollinworth, who preceded Mr. Makemson was also a London man.

British and World Shipbuilding

Lloyd's Register Returns for June Quarter

Steamships and motorships under construction in Great Britain and Northern Ireland at the end of June totalled 280 ships of 2,033,745 tons gross; a decrease of 215,107 tons as compared with the previous quarter, states Lloyd's Register of shipbuilding returns relating to merchant ships of 100 tons gross and upwards. The total comprises 82 ships of 512,247 tons fitting out afloat, and 198 of 1,521,498 tons still to be launched. Some 58 ships of 189,431 tons were commenced; 69 ships of 363,581 tons launched, and 90 ships of 417,426 tons completed.

The vessels under construction included 52 steamships of 1,019,995 tons and 228 motorships of 1,013,750 tons. In other British Commonwealth countries there were under construction 9 steamships of 97,830 tons and 48 motorships of 126,832 tons. Oil tankers building in Great Britain and Northern Ireland totalled 64 ships of 995,688 tons, a decrease of 96,103 tons compared with an increase of 27,596 tons in the previous quarter, and representing 49.0 per cent. of the total tonnage under construction in this country.

Vessels building in the world, excluding China, East Germany, and Russia, numbered 1,452 of 9,739,036 tons compared with 1,511 of 10,001,761 tons in the previous quarter. The total included 245 steamers of 4,619,244 tons and 1,452 motorships of 5,119,792 tons. Construction in hand in the principal districts of Great Britain and Northern Ireland is indicated in Table 1.

TABLE 1.—*Shipbuilding Construction in Hand in Principal Districts of Great Britain and Northern Ireland.*

District.	June 30, 1959.		March 31, 1959.		June 30, 1958.	
	No.	Gross tonnage.	No.	Gross tonnage.	No.	Gross tonnage.
Aberdeen ..	17	24,361	17	30,114	17	25,761
Barrow ..	2	67,500	2	67,500	3	94,000
Belfast	15	293,953	17	308,230	19	337,800
Bristol ..	1	3,500	2	4,850	3	6,200
Clyde:						
Glasgow ..	46	452,914	60	498,929	70	518,302
Greenock ..	23	143,520	24	164,296	29	158,810
Dundee.. ..	6	40,514	5	43,100	5	35,095
Hartlepool ..	3	25,710	4	28,200	7	53,640
Hull	38	12,461	38	15,176	36	17,267
Leith	8	32,326	10	44,319	11	61,657
Liverpool ..	12	111,638	12	111,678	12	106,202
Middlesbrough..	11	171,953	13	197,986	16	201,141
Newcastle-upon-Tyne ..	34	408,183	40	457,464	38	382,352
Southampton ..	7	11,064	9	8,717	9	3,669
Sunderland ..	24	215,489	25	245,244	31	268,380

The sizes of steamships and motorships (in parenthesis) under construction in Great Britain and Northern Ireland included the following:—100 to 500 tons, nil steam (94 motor); 500 to 1,000 tons, 3 steam (15), 1,000 to 2,000 tons, steam, nil (10); 2,000 to 4,000 tons, 3 steam (13); 4,000 to 6,000 tons, 2 steam (8); 6,000 to 8,000 tons, nil steam (18); 8,000 to 10,000 tons, 3 steam (29); 10,000 to 15,000 tons, 11 steam (36); 15,000 to 20,000 tons, 1 steam (1); 20,000 to 25,000 tons, 12 steam (4); 25,000 to 30,000 tons, 6 steam (nil); 30,000 to 40,000 tons, 8 steam (nil); 40,000 tons and above, 3 steam (nil).

There was under construction in the world at the end of June, 1,452 steamships and motorships of 9,739,036 tons gross, of which 20.88 per cent. is being built in Great Britain and Northern Ireland. The present total is 262,725 tons less than last quarter.

Of the steamships and motorships under construction throughout the world at the end of June, 5,310,184 tons (54.5 per cent.) are under survey by the Society for classification in Lloyd's Register Book.

Personal

Mr. L. BARRLING has taken up the appointment of foundry manager with Fabrica De Aco Paulista S.A., Sao Paulo, Brazil.

Mr. J. BRENNAN, works manager of Carntyne Steel Castings Company, Limited, has been appointed a director of the company.

Mr. A. D. LEWIS has relinquished his post with Henry Wallwork & Company, Limited, to join the staff of the National Foundry College, as a lecturer.

Mr. F. W. PERCIVAL has been promoted to the post of superintendent (ingot-mould foundry), with Guest Keen Iron & Steel Company, Limited, Dowlais, Glamorgan.

Mr. P. M. WILLIAMS has been appointed sales director of the Incandescent Heat Company, Limited, Birmingham, whilst retaining responsibility for the foundry-plant division.

Mr. R. C. LEPPINGTON has been appointed chairman of Hale & Hale (Tipton) Limited and subsidiary companies. Mr. J. A. WYLDE has been appointed managing director of Hale & Hale (Tipton), Limited.

Griffin & George, laboratory furnishers, announce that Mr. EDWARD BENTLEY leaves Manchester, where he has been branch manager for two years, to take up the senior post of London branch manager.

Mr. K. FEARNSIDE, 40, has been appointed to the board of Smiths Aircraft Instruments, Limited, as director of research. He was formerly research manager at the company's Cheltenham factory.

The British Cast Iron Research Association announce that Mr. I. C. H. HUGHES, M.SC., A.I.M., has been appointed research manager, and that Mr. A. G. FULLER B.SC., has been awarded the M.S. degree of the University of London for his work on shrinkage and porosity.

To mark his retirement (on August 28) after nearly 64 years of service with the English Steel Corporation, Limited, Sheffield, 77-year-old Mr. F. CRITCHLEY was presented with a gold watch by Mr. T. R. MIDDLETON, chief metallurgist and special director of the Corporation.

Sir NORMAN HULBERT, M.P., is to join the board of Dow Agrochemicals, Limited. The company is a British subsidiary of the Dow Chemical Company of America. It was formed in 1958 to manufacture and market agricultural chemicals in this country and its £1,000,000 factory is now under construction at King's Lynn, Norfolk.

At a recent meeting of the board of Aluminium Laboratories, Limited, in Montreal, Dr. R. T. PARKER was elected a director and vice-president of the company. Dr. Parker recently took charge of the Banbury and Geneva offices of the company in succession to Mr. R. D. HAMER. At the same meeting Dr. D. E. THOMAS, head of the department of patents and contracts was appointed an assistant secretary.

Sir ALEXANDER FLECK, chairman of Imperial Chemical Industries, Limited, will open the Scottish conference on "Relationships in Industry—Some Changing Concepts of Management" that is being organized jointly by the British Institute of Management and the Ministry of Labour. It will be held at Gleneagles Hotel, on October 23 and 24. Lord Monckton, chairman of the Midland Bank, will give the address at the closing dinner.

Mr. A. L. AYTON, F.C.I.S., a liveryman of the Worshipful Company of Fanmakers, has retired from his position as secretary of Keith Blackman, Limited, and the Blackman Export Company, Limited, nine days after celebrating his 50th year of service with Keith Blackman. He retains his seat on the board of directors of both companies. Mr. E. W. A. RICHARDS, F.C.I.S., hitherto assistant secretary, has been appointed secretary of both companies, and Mr. A. W. MILBORROW becomes chief accountant.

Mr. MAURICE TATTERSFIELD, has been elected to the board of the George Cohen 600 Group, Limited, following his appointment as financial controller of the group last year. His previous posts include those of director and secretary of Electro Hydraulics of Warrington, and of Conveyancer Fork Trucks, Limited; director of the Brush group of companies; and managing director of Brush Electrical Engineering, Limited. Mr. Tattersfield was at one time a Governor of Loughborough College of Technology.

The Minister of Supply has appointed Professor MICHAEL J. LIGHTHILL as Director of the Royal Aircraft Establishment, Farnborough, in succession to Sir GEORGE GARDNER, who (as reported last week) has been appointed to succeed Air Chief Marshal Sir CLAUDE PELLY as Controller of Aircraft at the Ministry in October. Professor Lighthill has been Beyer Professor of Applied Mathematics at the University of Manchester since 1950.

Obituary

Mr. PHILLIP JENKINS, a director of Robert Jenkins & Company, Limited, engineers, Wortley Road, Rotherham, has died at the age of 49.

Mr. W. H. PREVOST, founder and managing director of W. H. Prevost & Son, Limited, agricultural engineers, of Yaxley and Broadway, Peterborough, has died at the age of 75.

Mr. CHARLES JOSEPH RHODES, who died last week at the age of 84, was managing director of Joseph Rhodes & Sons, Limited, Grove Ironworks, Belle Vue, Wakefield, Yorks. The company was founded by his grandfather in 1924.

Mr. FRANK A. WATSON, a well-known figure in the light-castings industry in Scotland, has died at the age of 73. After training as a civil engineer, he joined the Larbert Art Metal Company, Limited, and in the early 1930s he took part in the establishment of the Scottish Enamelling Company, Limited, which was set up to exploit the processing of vitreous enamelling. He retired from the latter company, but retained his connection with the Larbert Art Metal Company.

Col. W. R. GLOVER died on August 25 at the age of 77. He was honorary president of Glover & Main, Limited, London, S.W.1, and had given 60 years' continuous service to the gas industry. He retired as chairman of the company last February. Col. Glover was a grandson of the founder of Thos. Glover & Company, Limited, gas-meter manufacturers and repairers, and he joined the company in 1900 as an apprentice under his uncle, the late Mr. J. G. Glover. Upon completion of his apprenticeship in 1905 he became manager of the company's Birmingham branch and was appointed a director in 1910. In 1919, following distinguished service with the Royal Fusiliers in the 1914-18 war, he was appointed managing director of Thos. Glover & Company, and in 1949 was appointed chairman of the Glover & Main group.

Apologies are made for the fact that in announcing the death of Mr. H. J. ROE in last week's "Obituary" his name was incorrectly spelled as Rowe.

News in Brief

THE BRITISH PRODUCTIVITY COUNCIL will, as from January next year, assume the responsibility for the publication of *Target* hitherto handled by the Central Office of Information.

A £1,500,000 BUS CONTRACT has been placed with Leyland Motors, Limited, and Metropolitan-Cammell-Weymann, Limited, by the Cuban company of Omnibus Metropolitanos S.A.

WHEN THE COOLING SYSTEM at the works of the Brightside Foundry & Engineering Company, Limited, Ecclesfield, Sheffield, failed recently, a fire engine was used to pump 7,000 gall. of water into the works.

"PROPERTIES OF CAST IRON AT ELEVATED TEMPERATURES" (ASTM Special Technical Publication No. 248), which was reviewed in last week's JOURNAL, p. 85, can be obtained in this country through Penton Publishing Company, Limited, price 35s.

BIRLEC, LIMITED, announce the establishment of a Midland-area sales office at the company's main premises in Tyburn Road, Birmingham 24. The manager of the new office is Mr. H. J. PODMORE who joined Birlec in 1955 as sales manager, dryer and gas plant division.

Mr. J. LITTLE of the trackwork department of Edgar Allen & Company, Limited, Sheffield, has left for Durgapur, India. He is to supervise the laying of trackwork supplied by Edgar Allen in conjunction with Dorman Long & Company, Limited, for the melting shops of the new steel plant.

RICHARD HILL LIMITED, Middlesbrough, a member of the Firth Cleveland group specializing in the design of reinforced concrete structures and in the manufacture of reinforcement, announce the setting up of a design office in the West Indies at 39 Half Way Tree Road, Kingston, Jamaica. Mr. A. J. Benghiat, B.SC., has been appointed manager of the office.

IN THE JOURNAL of August 20, when reporting the appointment of Mr. K. E. Walker as a director of F.C. Construction Company, the firm were described as ironfounders. This is incorrect, the firm are engineers and contractors in ferro-concrete construction, specializing in gas-works plant. Apologies are made to all who were confused by the error.

FOLLOWING A CHANGE in production patterns, with the company's products having a lower casting content than before, Baker Perkins, Limited, engineers, Westwood Works, Peterborough, have discharged 25 workers in their foundry, including skilled, semi-skilled and unskilled men. It is anticipated that all the remaining foundry workers will be needed.

THE BOROUGH POLYTECHNIC, Borough Road, London, S.E.1, in collaboration with the education committee of the Institute of Metal Finishing, has arranged a course of six lectures on plating-shop management and control. They will be given on Tuesday evenings, commencing October 6, at 7 p.m. Details are available from Mr. Fredk. J. Packer, F.C.I.S., at the above address.

DURING A FIRE which lasted 50 minutes at Clay Cross Ironworks, Derbys., on August 22, two 60-ft.-tall disused wooden cooling towers, which were being demolished, were completely destroyed. Colonel H. H. Jackson, joint managing director of the company, said that there was no serious damage to other parts of the plant and production would not be interfered with.

THE CO-OPERATIVE WHOLESALE SOCIETY, LIMITED, Manchester, as part of its rationalization policy, is to close down its ironworks at Keighley, Yorkshire. This decision follows the closure of the foundry two years ago. Employees of over 60 will be allowed to retire on full pensions before the normal retiring age of 65, and others will receive *ex gratia* payments up to a limit of 10 weeks' salary.

A £2,000,000 CONTRACT for the supply of a sugar factory to Iran by the John Brown Construction firm will be shared by the Paisley engineering firm of A. F. Craig & Company, Limited. The two companies are to provide processing equipment to deal with 1,000 tons of sugar-beet per day. The factory, ordered by the Sherkat Shami Ghandi Pars Company, is expected to be completed by 1961.

QUASI-ARC, LIMITED, of Bilston, Staffs, have announced their intention of reducing the price of arc-welding electrodes, as the company proposes to pass on the benefits of recent reductions in the price of hot-rolled mild-steel rods—the basic material for manufacturers drawing their own wire. The new price reductions will apply to all deliveries of mild-steel electrodes made on and after October 1.

G. C. OGLE & SONS, LIMITED, agricultural implement manufacturers, Ripley, Derbyshire, is to close its foundry. Mr. Humphrey Ogle, the works manager, has said in a statement, that it is no longer economical for the firm to do its own casting because of recent changes in production. Steel fabrication is being increasingly used and the work will be handled by an outside firm. G. C. Ogle expect to find their foundry workers alternative employment in the firm.

AN INTERNATIONAL FILM FESTIVAL is to be held in Oxford from September 23 to October 2. It is the 13th Congress of the International Scientific Film Association at which representatives of documentary and scientific film organizations from 25 countries will be taking part. During the ten-day Congress the delegates will see more than 100 films from overseas. The rapid growth of the International Scientific Film Association which was founded in 1947, reflects the increasing importance of the work. It now has a membership of 30 nations many of them being the Eastern European lands—also Japan.

IMPORTANT CHANGES in factory law have been introduced by the Factories Act 1959. Mr. Harry Samuels, O.B.E., M.A., barrister-at-law, will explain what these changes mean in practical terms at a meeting for industrial executives arranged by the Industrial Welfare Society. The meeting, which will be held at the IWS headquarters, Robert Hyde House, 48, Bryanston Square, London, W.1, is open to non-members. It takes place at 2.30 p.m. on September 16. The fee for the meeting is £2 2s, for delegates from IWS member organizations and £2 10s. for those from non-members.

A CONVENTION ON SOCIAL SECURITY between the United Kingdom and Denmark was signed in London last week. Mr. Julius Bomholt, the Danish Minister for Social Affairs, came to this country for the signing of the convention on Tuesday of last week, and other signatories were Mr. Birger Ove Kronmann, Charge d'Affairs at the Danish Embassy; Mr. Selwyn Lloyd, Foreign Secretary; and Mr. John Boyd-Carpenter, Minister of Pensions and National Insurance. Mr. Ivan Neill, Minister of Labour and National Insurance for Northern Ireland, was also present. Mr. Bomholt returned to Denmark on Friday last.

News in Brief

TWO BLOWING ENGINES, made in 1851 by Murdoch and Aitken, are awaiting their fate at the Lilleshall Company, Limited, Oakingates, Shrops., where the blast furnace was recently closed down. The engines are highly ornamental with Doric columns and elaborate decorations, and are known as Sampson and David. Mr. C. R. Nicholls, secretary and director of the company, said that the firm had been in touch with the Newcomen Society and with the Ministry of Works with regard to the preservation of the engines for their historical interest. He added that unless a decision were reached quickly the two veterans would have to go for scrap.

TUBE INVESTMENTS SUBSIDIARY COMPANY, Brookes (Oldbury), Limited, has received an order from V/O Stankoimport, Moscow, USSR, for two double internal-tube polishing machines complete with dust-extraction equipment and necessary ancillary equipment. The value of the orders is over £30,000. The machines are for the internal polishing to mirror finish of stainless-steel tubes as used in the dairy, brewing and food industries. They polish two tubes simultaneously up to 40 ft. long. Earlier in the year, the steel-tube division of Tube Investments received Russian orders for stainless and alloy-steel tubes valued in excess of £2,000,000.

THE LICENSEES IN JAPAN of the Power-Gas Corporation, Limited, Stockton-on-Tees, Mitsubishi Chemical Machinery Manufacturing Company, Limited, of Tokyo, have received an order for one unit of carburetted water gas plant, with a capacity of 2,000,000 cub. ft. per day, for the Saibu Gas Company. Earlier this year the Power-Gas Corporation (Australasia) Pty., Limited—an overseas member of the Power-Gas group of companies—received an order for one unit of c.w.c. plant with a normal capacity of 9,000,000 cub. ft. per day and with a peak load capacity of 12,000,000 cub. ft. per day. This plant is to be installed at the Mortlake Works, Sydney, of the Australian Gas Light Company.

THE VALUE of industrial and commercial firms having works fire brigades was stressed by Chief Fire Officer B. Jones, head of Sheffield Fire Brigade and president of the Yorkshire Industrial Fire Brigades' Association, in a foreword to the programme for the fire brigade competitions held at the sports ground of Brown Bayley Steels, Limited, Olivers Mount, Darnall, Sheffield, on August 29. He stated that the brigades were useful not only for the extinguishing of fires but also for the knowledge the men had of the causes of fires in works, and the removal of them. Constant vigilance and practice was necessary, he said, and added that it was good to see that many managements realized the value of having a works fire brigade.

Mr. G. Y. MANGRULKER, head of the staff-training centre of the Tata Iron and Steel Company, Limited, Jamshedpur, India, is to visit Britain for a six-week study tour arranged by the Industrial Welfare Society. The objective of the visit, which will run from September 16 to November 2, is to examine a variety of staff training centres and to discuss with British experts the current trends in training practice. Among others, Mr. Mangrulker will visit the staff residential course of the United Steel Company, Limited, the staff college of Richard Thomas & Baldwins, Limited, and the management college of the British Iron and Steel Federation. Tata's staff-training centre has been in existence for about four years, and the company now intends to extend the work of the centre to include management development.

Scottish Industries Exhibition

A British Railways station has been renamed to commemorate the 1959 Scottish Industries Exhibition which is being held from September 3 to 19 in the Kelvin Hall, Glasgow—Partick Central Station, which is about half a mile from the Exhibition site, is now known as "Kelvin Hall" station. (The number and avenue in brackets alongside the firm's name is the stand number and location.) Stands of special interest to readers include :

KELVIN & HUGHES, LIMITED (*15, Kelvin Avenue*) are exhibiting a simulator unit of an automatic boiler-control installation, and examples from their range of ultrasonic flaw-detection equipment.

STEWARTS AND LLOYDS, LIMITED (*15, Hunterston Avenue*) are displaying steel tubular products, and a selection of steel castings with supporting photographs.

ELECTRIC RESISTANCE FURNACE COMPANY, LIMITED, are showing furnaces in operation for the bright-hardening of small parts, and a model of a new-type furnace incorporating a closed quench. This new furnace is a vertical cylindrical atmosphere furnace, combining the advantages of pit-gear gas carburizers with facilities for closed quenching hitherto available only in horizontal equipments.

KEITH BLACKMAN, LIMITED (*24, Grange Avenue*). Exhibits of particular interest are: the recently introduced "Aristocrat" centrifugal fan for general applications; 19-in. axial fan for general industrial and marine ventilation purposes, and a two-stage, 20-in., cast-iron blower.

G. & J. WEIR, LIMITED (*4, Clyde Avenue*) show three entirely new marine units: a diesel starting air compressor, a vertical marine evaporator with built-in distilling condenser, and a single-stage, turbine-driven boiler-feed pump which runs at 10,000 r.p.m.

* * *

Trade Drive

The Scottish Industries Exhibition, which Princess Margaret opens to-day (Thursday) in Glasgow, is to be followed by an intensive drive for trade in territories as dissimilar as the Soviet Union and North America. So far the Scottish Council (Development & Industry), who resolved in principle in June to sponsor a mission to Russia, have been approached by seven different companies and trading groups who are genuinely interested in that project. The question of how it should be organized is now being discussed with the Board of Trade.

An association of the Robinson family with the Staveley Iron & Chemical Company, Limited, Chesterfield, lasting since 1810, has ended with the retirement of Mr. CHARLES W. ROBINSON, a technician in the works foundry department. He started as an apprentice with Markham & Company, Limited, constructional engineers, Chesterfield, and then went to the Staveley Works where he had completed 38 years in the foundry department on retirement. His grandfather became the first secretary of the company in 1863, after members of the family had already served for over 50 years with the firm. The father of Mr. Charles Robinson worked in the patternshop for many years.

Raw Material Markets

Iron and Steel

Plenty of foundry pig-iron in all grades is available; in fact, appreciable stocks are still being held by the furnaces, mainly hematite, low- and high-phosphorus, and the refined-iron makers would also appreciate additional business. The motor foundries and the foundries specializing in castings for this industry are well employed and are calling for considerable quantities of low-phosphorus iron, hematite, and refined pig. The general engineering foundries, including the machine-tool makers, are busier than they have been and, here again, their requirements are largely for hematite, low-phosphorus, and refined iron.

The somewhat improved position in the light foundries and textile engineering foundries is maintained, but most of them could easily take on additional business. The foundries are confining their purchases to small quantities to cover their early requirements.

Pig-iron makers are interested in export inquiries, but in many cases their prices are higher than those of the continental producers.

Coke supplies for the foundries are coming through to schedule. No difficulty has been experienced either in Durham or South Wales in meeting current needs and foundries find it unnecessary to carry heavy stocks because deliveries are usually quite prompt.

There has been a considerable change at the re-rollers during the last two months or so. Business has increased considerably for light sections, small bars, etc., and re-rollers are once again placing appreciable orders to cover their requirements for the next two or three months; such orders cover a tonnage for stock, as reserves were run down to a low level while trade was poor. Makers of billets are well covered until October and some even beyond this period. There is also an improved demand for seconds and short billets suitable for the re-rolling industry.

Non-ferrous Metals

The strike position in the United States continues to dominate copper markets throughout the world. The London market after earlier weakness is showing signs of strength. The revival set in towards the end of last week when rumours circulated of a difficult labour situation brewing up at the Braden copper mine in Chile. New York also hardened on this information and the change in attitude so induced was kept going by the feeling that the present strike in the US may last a long time. This latter feeling is not new. Indeed, there have been many inquiries on the London and continental exchanges for copper for shipment to the US, but actual buying has been lower than had been expected. It now transpires that the one reason of substance overlooked on this side of the Atlantic has been the threatened strike of American longshoreman. The threatened longshoreman strike is due to begin on October 1 and because of it all available freight space has been booked in advance. This, coupled with the fear that no shipments could be landed after this time, even if freight space were available, has held demand down well below what could have been reasonably expected.

In these circumstances the US price structure has remained unchanged, with both custom smelters and primary producers quoting 30 cents a pound. In the UK the price has firmed up several points due to the above features and also to the reappearance in the market of Russian buyers. How long this will continue is impossible to say. If past experience can be relied upon, it will cut off suddenly without warning in a very short time.

The proposal put forward last week by the European Mineworkers that the Rhodesian copper mines should be nationalized has not had much of a reception. Quite aside from it being shrugged off in the market in London, it now seems that there is disagreement on this proposal within the Union. In any event, it would be interesting to know how the proposal could be implemented in practice without resorting to the worst kind of expropriation procedure as the finance required for such an operation may be gathered when it is known that Nchanga alone is valued in the market at approximately £87,000,000.

Tin is a quiet market and without feature. This is mainly due to the United States steel strike, which has hampered American buying for some time. It is, however, also due to the fact that the International Tin Council meeting, which opened in London on Tuesday, has been overhanging the market, which always prefers to wait and see. The US price is fluctuating narrowly around $1.03 a pound.

Lead is dull, and even the threatened strike at Bunker Hill failed to stir the market. Nevertheless, the volume of trading is satisfactory in London and the price is holding its own on both sides of the Atlantic. In the US the quotation is 13 cents a pound. Zinc continues to be routinely satisfactory. Turnover has tended to fluctuate in accordance with the market for copper in London. The market is steady in the US, where the price is called 11 cents, East St. Louis.

Latin American Business Prospects

Mr. W. T. Hale of Thomas Marshall & Company (Loxley), Limited, Sheffield, on his return recently from a visit to South America, held a Press conference at the Wig and Pen Club in Fleet Street, London, E.C.4. Last year his firm received export orders to the value of £45,000 for blast-furnace linings in the face of severe international competition. This company has successfully lined no fewer than 165 blast furnaces and heartened by the receipt of additional orders, Mr. Hale went to South America to investigate the market for refractories in Brazil and Chile. At the Press conference, he stated that it would be possible to secure orders in those areas for UK plant and equipment, only until such time as the same items could be manufactured locally. He also expressed the opinion that, so far as his firm was concerned, British credit facilities were inadequate, and better conditions were being offered by Japan and Western Germany to their exporters. The Editor of the JOURNAL is not too sure that Mr. Hale is correct, as in reviewing the whole picture of exports, it may be that money can be lent with greater safety in other markets.

"Dip. Tech." Awards

The second list of awards of diplomas in technology has been issued by the Board of Education: all the candidates studied at Battersea College of Technology. First-class honours in engineering were gained by P. W. Lightfoot and D. J. Pollard; second, by A. E. Freeman, and a pass by B. C. Rogers. In metallurgy, firsts were gained by K. Bolton and B. L. Eyre, and second-class honours by A. L. Greenwood and W. H. Hodgson. There are now 2,500 students taking courses leading to the diploma, an award equal in standing to a university honours degree.

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

September 2, 1959

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2, 10-ton lots or over: Middlesbrough, £21 6s. 0d.; Birmingham, £20 18s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.40 per cent. P, 6-ton lots or over, £23 5s. 0d., delivered Birmingham, £23 10s. 0d., delivered Grangemouth.

Cylinder and Refined Irons.—North Zone, £25 6s. 6d.; South Zone, £25 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.: North Zone, £26 6s. 6d.; South Zone, £26 9s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent., 6-ton lots or over: N.-E. of England (local iron), £24 14s. 0d.; Scotland (Scotch iron), Zone S.1, £25 0s. 6d.; Sheffield, £26 2s. 6d.; Birmingham, £26 11s. 6d.; Wales (Welsh iron), £24 14s. 0d.

Basic Pig-iron.—£20 3s. 0d., delivered Staffs, Derbyshire, Notts, Lincs, Rutland, Northants, and Leicestershire, in 6-ton lots or over.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £41 0s. 0d. to £43 10s. 0d., scale 15s. 0d. per unit; 75 per cent. Si, £56 10s. 0d. to £60 10s. 0d., scale 15s. 0d. to 16s. 0d. per unit.

Ferro-vanadium.—50/60 per cent., 22s. 6d. per lb. of V.

Ferro-molybdenum.—65/70 per cent., carbon-free, 12s. 10d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., 2-3 per cent. Cu, £250 0s. 0d.; 38/40 per cent., commercially carbon-free, £287 0s. 0d.

Ferro-tungsten.—80/85 per cent., 8s. 10d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 11s. 10d. per lb. of W.

Ferro-chrome (6-ton lots and over).—4/6 per cent. C, £77 0s. 0d. to £81 0s. 0d., basis 60 per cent., Cr, scale 26s. 0d. to 27s. 6d. per unit; over 6 per cent. C, £74 10s. 0d. to £77 10s. 0d., basis 60 per cent. Cr, scale 26s. 0d. to 27s. 6d. per unit; 2 per cent. C,* 1s. 7½d. to 1s. 10½d. per lb. Cr.; 1 per cent. C,* 1s. 8d. to 1s. 11d. per lb. Cr; 0.15 per cent. C,* 1s. 9d. to 2s. 0d. per lb. Cr; 0.10 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr; 0.06 per cent. C,* 1s. 9¾d. to 2s. 0¾d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 10d. per lb.

Metallic Manganese.—94/96 per cent., carbon-free, £245 0s. 0d.; 96/98 per cent., £275 0s. 0d.

Ferro-columbium.—65/72 per cent., Cb + Ta, 19s. 9d. per lb., Cb + Ta.

Ferro-manganese (standard).—78 per cent., £66 0s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft u.t., 100 tons & over, £31 15s. 6d.; tested, 0.08 to 0.33 per cent. C, 6 to 35 tons, £33 15s. 6d.; hard (0.41 to 0.60 per cent. C), under 10 tons, £34 17s. 0d.; silico-manganese, under 10 tons. £43 16s. 6d.; free-cutting, under 10 tons, £36 14s. 6d. SIEMENS MARTIN ACID (under 10 tons): Up to 0.25 per cent. C, £41 1s. 0d.; silico-manganese, £44 4s. 0d.

Billets, Blooms, and Slabs for Forging and for Stamping (under 10 tons).—Basic, soft, up to 0.33 per cent. C, £38 10s. 0d.; basic hard, over 0.41 up to 0.60 per cent. C, £39 12s. 6d.; acid, up to 0.25 per cent. C, £43 4s. 0d.

* Average 68–70 per cent.

FINISHED STEEL

Heavy Plates and Sections (under 10 tons).—Ship plates, (N.-E. Coast), £42 2s. 0d.; boiler plates (N.-E Coast), £44 12s. 0d.; floor plates (N.-E. Coast), £43 11s. 0d.; angles (N.-E. Coast), £39 16s. 6d.; joists (N.-E. Coast), £39 12s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., and flats 5 in. wide and under, untested soft basic, 50 tons and over, £39 1s. 0d.; under 10 tons to 4 tons, £40 18s. 0d.; under 4 tons to 2 tons, £41 3s. 0d.; hoop and strip, coils, 100 tons and over, £38 0s. 0d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., 25 tons to under 50 tons, £43 16s. 0d.; black sheets (hand mill), 24g., 10 tons and over, £57 14s. 6d.; galvanized corrugated sheets, 24g., 10 tons and over, £67 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £68 10s. 0d.; nickel-chrome, £99 4s. 0d.; nickel-chrome-molybdenum, £111 17s. 0d., in lots of 5 tons to under 10 tons.

NON-FERROUS METALS

Copper.—Cash, £237 0s. 0d. to £237 5s. 0d.; three months, £234 15s. 0d. to £235 0s. 0d.; settlement, £237 5s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 2s. 3½d. per lb.; rods, 251s. 0d. per cwt. basis; 20 s.w.g., 286s. 0d. per cwt.

Tin.—Cash, £792 0s. 0d. to £792 10s. 0d.; three months, £792 0s. 0d. to £792 10s. 0d.; settlement, £792 10s. 0d.

Lead (Refined Pig).—First half September, £71 10s. 0d. to £71 15s. 0d.; first half December, £73 2s. 6d. to £73 5s. 0d.

Zinc.—First half September, £86 0s. 0d. to £86 10s. 0d.; First half December, £85 0s. 0d. to £85 5s. 0d.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £121 15s. 0d.; rolled zinc (boiler plates), all English destinations, £119 10s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £101 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 1s. 10¾d. per lb.; sheets to 10 w.g., 202s. 6d. per cwt.; wire, 2s. 8¼d.; rolled metal, 202s. 6d. per cwt.

Brass (Brazing).—BS1400, B3, £156; B6, £200.

Brass (High Tensile).—BS1400, HTB1, £185; HTB2, £202; HTB3, £214.

Gunmetal.—BS1400, LG2, £193; LG3, £203; G1, 1%, £263; G1, 1%, £242.

Phosphor Bronze.—BS1400, PB1 (AID released), £289; BS1400: 90/10/1, £266.

Leaded Phosphor Bronze.—BS1400, LPB1, £213.

Phosphor Bronze Strip, etc.—Strip, 290s. 9d. per cwt.; wire, 4s. 1½d. per lb.; rods, 3s. 5d.; tubes, 3s. 5d.; chill cast bars: solids 3s. 4d.; cored 3s. 5d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 10½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 3½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 2½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £190 0s. 0d. Quicksilver, ex-warehouse, £71 10s. 0d. Nickel, £600 0s. 0d. Aluminium, ingots, £180 0s. 0d.; aluminium bronze (BS1400), AB1, £236; AB2, £247.

This rock-bottom price of £66 even includes Push-Button Control Handle and Chain Collector.

Throw away

your labour-wasting lifting device

ONLY **£66** buys you the WORLD'S BEST 5 cwt ELECTRIC HOIST:

ACROW DEMAG BANTAM

Guaranteed by DEMAG-ZUG, world's largest hoist makers

Sole U.K. Agents for Demag-Zug, Wetter

ACROW (ENGINEERS) LTD., Demag Division, SOUTH WHARF, LONDON, W.2. : AMBassador 3456 (30 lines)

LOW PHOSPHORUS
REFINED & CYLINDER
HEMATITE
MALLEABLE
DERBYSHIRE
NORTHAMPTONSHIRE
SWEDISH CHARCOAL

PIG-IRON

WILLIAM JACKS & CO. LTD.

LONDON, E.C.2.
Winchester House, Old Broad Street
London Wall 4774 (6 lines)

FERRO SILICON 12/14%
ALLOYS & BRIQUETTES
N.F. METALS & ALLOYS
LIMESTONE
GANISTER
MOULDING SAND
REFRACTORIES

And at:—

BIRMINGHAM, 2. 39, Corporation St., Midland 3375/6
LIVERPOOL, 2. 13, Rumford St., Central 1558
GLASGOW, C.2. 93, Hope Street, Central 9969

American Letter

Ford's New Light-castings Industry

Industrial Heating is an American technical journal, and a recent issue carried an illustrated description of the Ford Motor Company's new engine and foundry division plant in Sheffield, Alabama. It is outstanding inasmuch as it brings molten aluminium from the nearby Reynolds Metal Company, which smelts this metal from alumina. The metal leaves the smelter at a temperature of 925 deg. C. to fill 4½-ton ladles, having been alloyed to Ford's specification. These ladles are hauled—two on a flat-bed trailer—over a private road to the nearby Ford plant, when the temperature will be of the order of 850 deg. C. In the foundry building there are 14 Lindberg reverberatory furnaces which, using a 15-ton overhead crane, are filled from the ladles through the spout. Eight of these furnaces have a capacity of 29 tons and are used for holding the metal at the desired temperatures. Natural gas is the main fuel used, but light fuel-oil is used as a standby. The other six furnaces have a capacity of about 9 tons, and four of them are used for remelting scrap. One of these is very interesting, as it is used for castings containing steel inserts. Thus it is provided with a sloping hearth, which allows the molten aluminium to drain away leaving the steel components high and dry and easily raked out of the furnace.

Quality Control

Quality control starts with the careful charging of the holding furnaces, which assures a minimum of dross formation. Chlorine gas is piped directly to each of the furnaces and the bath, after fluxing and skimming, is allowed to stand for a fixed period before sampling. It sometimes happens that a second treatment is required in order to comply with the specification, and no metal is released without being approved and the details recorded. The molten metal is discharged through a tap-out block into a cab-mounted 1-ton capacity transfer-ladle, monorail suspended. When the ladle is filled, a 2-lb. solid-flux degassing tablet is introduced and submerged using an inverted steel bell, after which resampling takes place. If this is satisfactory the ladle goes to the casting area. Here there are Lindberg-Fisher electric resistance reverberatory-type holding furnaces either of 12- or 18-cwt. capacity. At this point the metal is often flushed with bottled nitrogen as an assurance against porosity. Much of the production goes to feed both gravity- and pressure-die casting machines, making castings weighing up to 30 lb.

Copper in Cast-iron*

Copper in cast-iron has practically no direct effect on the properties of the graphite phase. It is not a carbide-forming element, and only a few copper atoms can be dissolved in cementite, the physical properties of which thus remain practically unaffected. At the solidification stage copper is a mild graphitizer (this effect is well known)—its graphitizing effect is estimated as being between one third and one fifth that of silicon. According to the author's experience, it is a milder graphitizer than nickel. Copper also has a dendrite structural refining effect. The effect of copper as a refiner is difficult to estimate in the case of flake graphite. The refining effect on cementite and graphite is due to a retarding influence of copper on the carbon diffusion rate. Smaller individual crystals mean a larger number.

The anti-ferritizing power of copper, compared with nickel and with tin, showed that nickel additions up to 6.4 per cent. resulted in an acicular structure, but did not completely eliminate the ferritic "bulls-eyes' in s.-g. iron. However, additions of copper at 0.8 per cent. were sufficient to eliminate the bulls-eyes and give a fully pearlitic matrix. Thus, it appears that copper is a powerful anti-ferritizer. In the same series of experiments, a fully pearlitic matrix was obtained with a 0.06-per cent. tin addition, resulting in a 0.03-per cent. residual tin content. The anti-ferritizing effect of copper, tin and other elements is not limited to s.-g. iron, but flake graphite irons need larger amounts of anti-ferritizing additions because of the much larger graphite/austenite interface surface. The anti-ferritizing effect of copper has long been known, but it has been set out in the wrong way and generally misunderstood. Indeed, in many technical papers it is said that copper is a pearlite stabilizer, which statement is fundamentally wrong. However, it is correct to say that copper is a pearlite-formation promoter.

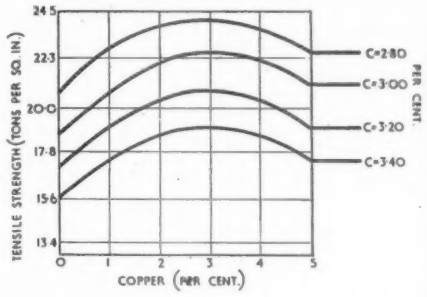


FIG. 1.—*Graph showing tensile strength according to copper content in cast-iron for different amounts of carbon (¾-in. dia. test-bar as-cast; Si*—1.8 *to* 2.0; *Mn*—0.50, *and P*<0.10 *per cent.*).

Copper is also an austenite stabilizer. As the ferritizing reaction proceeds, copper must concentrate in austenite, in a similar manner to that in which (for an analogous reason) silicon concentrates in ferrite. Thus, increased copper concentration in austenite corresponds to increased austenite stability, and consequently to a lower reaction-rate. However, the retarding effect based only on austenite stabilization is probably unimportant, since nickel has an equal or even higher austenite-stabilizing effect but does not substantially retard direct ferritization.

Recent experiments on a TC 3.20, Si 1.50 per cent. cast-iron (melted in a high-frequency furnace and cast into 1¼-in. and ¼-in. dia. test-bars) reaffirmed the quantitative influence of copper additions to grey cast-iron. The hardness and strength values increased as shown in Fig. 1, and the impact strength decreased moderately with increasing copper contents. It seems that copper is a graphitizer at the solidification stage, as well as an anti-ferritizer through the transformation cooling-range, and that a more uniform structure (having good overall strength and hardness properties) may be imparted to grey iron by copper additions.

* Synopsis of a paper, by Albert de Sy (head of metallurgy department, University of Ghent, Belgium), presented at the AFS Congress in Chicago, in April.

Farnborough Exhibition

The Society of British Aircraft Constructors' Flying Display and Exhibition will be held as usual at Farnborough this year, from September 7 to 13. Some of the stands which will be of major interest to foundrymen are briefly reviewed below (the figure in brackets after the firm's name is the stand number).

SOLARTRON ELECTRONIC GROUP will demonstrate some of their newest developments in all-electronic simulator systems.

TALBOT STEAD TUBE COMPANY, LIMITED (*211*), will show stainless heat-resisting seamless, welded, and welded and drawn, steel tube in both straight and manipulated forms.

NORTHERN ALUMINIUM COMPANY, LIMITED (*131*). The chief exhibit will be a wing skin panel, 23 ft. long and 23 in. wide, machined from plate in Noral B26S WP alloy (DTD5020) for Vickers Vanguard. A range of intricate aircraft castings will also be displayed.

ENGLISH STEEL CORPORATION, LIMITED (*273*). Four wholly-owned subsidiary companies combine together on one stand to show an interesting group of items selected from the wide range of products which they manufacture for the aircraft industry.

SIMMONDS AEROCESSORIES, LIMITED, and FIRTH CLEVELAND INSTRUMENTS, LIMITED (*188*). An aircraft fuel-dispensing unit, an entirely new range of light-weight all-metal stiffnuts, and a miniature barograph are amongst the new products displayed.

MOND NICKEL COMPANY, LIMITED (*171*). A full range of technical publications dealing with the use of nickel-containing materials in modern industry, with particular reference to the aeronautical field, will be available. In addition, the stand will be staffed by members of the Company's development and research department, who will answer technical enquiries.

MANCHESTER OIL REFINERY (SALES), LIMITED (*89*), will be demonstrating the uses of M.O.R. inks for the non-destructive flaw detection of aircraft components. The first group of inks utilizes the magnetic-particle method of testing, and the second demonstrates the penetrant-testing of magnetizable and non-magnetizable articles.

SAMUEL FOX AND COMPANY, LIMITED, and STEEL PEECH AND TOZER, LIMITED (*132* and *133*), are to stage a joint exhibition. Exhibits will include a jet-engine combustion chamber, and a display of rolled-steel rigs used in gas-turbine engines.

DESOUTTER BROTHERS, LIMITED, will be exhibiting four new portable pneumatic power tools, a reversible screwdriver, a corner screwdriver and nutrunner, a new grinder, and a reversible corner nutrunner.

SMITHS AVIATION DIVISION (*1* to *4*). Central feature of the stand will be a pictorial display of the "Autoland" automatic landing system. Also to be seen for the first time will be the new type-4 Smiths Flight System, thermocouples and harnesses featuring compacting techniques, a new miniature relay and the new A.R.B.-approved civil altimeters.

ALBRIGHT & WILSON (MFG.), LIMITED (*123*). A wide range of Kanigen-plated components will be shown. Kanigen is a new nickel-phosphorous plate deposited by chemical reduction which can be applied to all ferrous metals, aluminium, titanium, copper and brass.

HENRY WIGGIN AND COMPANY, LIMITED (*17*). The theme of this stand will be the progress made in the development of the Nimonic series of alloys.

Foundry Furnishings

Hark! I hear the Foundry Foreman,
Bellow to the Foundry Storeman,
What have you inside that door man?
HOOKER'S goods I hope!

Why not take a look man,
In my Order Book man?
Hammers, rammers, Die Slick pails,
Wood flour, forks and foundry nails,
Chisels, chaplets, straw in bales,
From HOOKER'S Foundry Store.

Said the Storeman to the Foreman,
We have HOOKER'S goods galore man,
Nothing else goes in that door man,
While I'm in the Store.

Yes, we've all that matters,
Even foundry ratters,
If you've pestilential rats
Try HOOKER'S brand of ratting cats
And keep the news beneath your hats,
Future stocks assured.

239a FINCHLEY ROAD, LONDON, N.W.3
Telephone: Swiss Cottage 3281-2-3

Company News

WILLENHALL MOTOR RADIATOR COMPANY, LIMITED—The interim for 1959 is raised from the equivalent of 3¾ per cent. to 5 per cent. on capital doubled by a scrip issue. A total equivalent to 15 per cent. was paid for 1958.

INTERNATIONAL COMBUSTION (HOLDINGS), LIMITED—An interim dividend of 10 per cent. compares with a corresponding payment of 7½ per cent. The dividend has been increased solely with a view to reducing the differential between the interim and final dividends.

HARTLEY & SUGDEN, LIMITED, boilermakers, etc., of Halifax—The offer by F. Francis & Sons (Holdings), Limited, manufacturers of metal containers, etc., of London, S.E.13, to acquire the company's capital has become unconditional and the acceptance date was extended to September 1.

B. ELLIOTT & COMPANY, LIMITED, machine-tool makers, of London, N.W.10—The sharp reduction in profits forecast in the interim review, was due to the substantial reduction in turnover which resulted from the low level of demand for standard machine tools, and the closing of the South Wales factory. Orders over the past few months, however, have shown a substantial increase. Group trading profits fell sharply to £201,345 (£379,515) in the year ended March 31, 1959, and the dividend is reduced to 17½ (30) per cent. with a 10 (22½) per cent. final.

WALKER BROS., LIMITED, constructional engineers and sheet-metal workers, etc., of Walsall (Staffs)—At the present stage the company is well on its way to equalling the figures for the year ended March 31, 1959, and, states the chairman, Mr. T. A. W. Allen, they could be even better. It is not expected that the parent company will have a particularly good year, but the period opened very well for Benford, Limited. Group profits, before tax, at £256,750, were 28 per cent. up on the previous year, and an equivalent dividend of 30 (17½) per cent. is being paid.

ENGINEERING COMPONENTS, LIMITED—Sales during the first six months of 1959 show an increase over the corresponding 1958 period, production increased steadily, and order-books reflect the general increase in activity, according to the chairman, Mr. C. C. Griffith. He adds that this tendency should continue. Profit, before tax, for the six months amounted to £240,000 and in order to reduce the disparity between interim and final payments the directors have doubled the interim dividend at 5 per cent., but they emphasize that this does not indicate a higher total for the year. Final for 1958 was 12½ per cent.

ALBRIGHT & WILSON, LIMITED, holding company for manufacturers of industrial chemicals—The company is raising its interim dividend from 4 per cent. to 6 per cent. on the £5,704,519 ordinary in respect of 1959, and proposes a one-for-four scrip issue. The directors emphasize that both the increase in dividend and the issue are intended as technical adjustments, the first to make the interim a higher proportion of the total distribution, and the second to reduce the disparity between issued capital and total shareholders' funds employed. Neither individually nor taken together should the adjustments be considered to imply in themselves an increase in the total distribution. The scrip issue is applicable to holders of September 4. Group net profit in the six months to June 30, 1959, rose to £1,122,000 from £793,000 in the corresponding period of 1958. Present indications are that profits for the remainder of 1959 may be slightly lower than those reported for the first half-year.

American Nickel Stockpile

The General Services Administration announced in Washington on August 26 that under agreements reached with the International Nickel Company of Canada, Limited, the Government will be relieved of all existing obligations to purchase nickel from the company for the Government stockpile. Under the agreements, Inco has agreed to cancel all remaining deliveries of nickel under the company's "market price" contract.

Inco has also agreed that the nickel remaining deliverable under the company's "premium price" contract for the production of nickel from high cost marginal ores will be diverted into the market instead of being delivered to the Government. The Government in turn will pay the company for difference between the market price and the contract price under the "premium price" contracts—payment to be made in Government-owned nickel oxide sinter, which is in excess supply.

Monsanto Chemicals Improvement

Increase in the half-year's net sales and income, compared with the corresponding 1958 period, of Monsanto Chemicals, Limited, is an encouraging indication of both greater demand for and output of products, states Sir Miles Thomas, chairman. Results were mainly due to increased business done and improved efficiency in the manufacture of previously established products. Export sales accounted for 37 per cent. of trade.

Net sales rose to £8,726,720 (£7,489,848) and income for the six months to £371,611 (£247,642), after charging estimated taxes of £348,400 (£284,100). The figures relate to the company and its UK subsidiaries only and do not include earnings of the Australian subsidiary.

A maintained interim of 5 per cent. is declared on the £5,400,000 ordinary capital. The previous year's total was 13½ per cent.

George Kent Rights Issue

A rights issue to ordinary stockholders of 540,000 10s. ordinary shares at 30s. a share in the ratio of three new shares for every eight 10s. stock units held is to be made by George Kent, Limited, industrial instruments and automatic control manufacturers, of Luton (Beds).

Net proceeds are estimated at £791,500 and will be applied in repaying the bank overdraft which at August 12 was £561,912, in financing capital expenditure already approved, and in providing additional working capital to finance anticipated increased sales of the instrument division.

The new shares will not rank for the final dividend for the year to April 4 last. Current year profits are expected to be at least up to last year's level and the directors are confident they will be able to maintain the ordinary dividend at 17 per cent. on the increased capital.

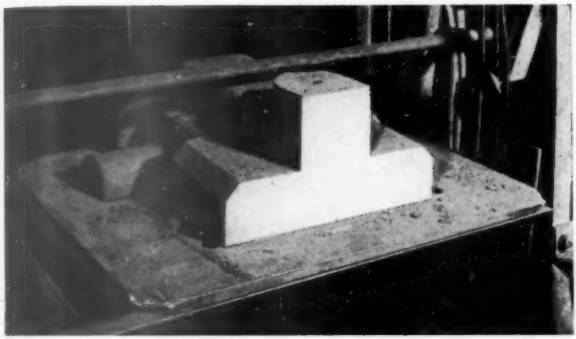
IMPERIAL ALUMINIUM COMPANY, LIMITED—The board of this company, which has been formed to link Imperial Chemical Industries, Limited, with the Aluminum Company of America in the manufacture of wrought aluminium products, has been constituted as follows:—From ICI: Dr. James Taylor (chairman); Mr. Berkeley Villiers (managing director); and Mr. Michael Clapham. From Alcoa: Mr. DuBose Avery and Mr. F. J. Resch.

For Rapid Baking . . .

FOUNDRIMET FOUNDRY & METALLURGICAL F&M.S.L.D.

SUPINOL RB 314
CORE OIL

(Patent applied for)



Reduce Baking Time by as much as 50%.

HIGHER DRY STRENGTH THAN LINSEED OIL AT SHORTER BAKING CYCLES

- Economical in use
- More gallons per ton
- Not critical to Baking Temperature
- Cores uniformly baked

MANUFACTURED BY

F & M SUPPLIES LIMITED

4, BROAD STREET PLACE, LONDON, E.C.2.
Telephone: LONDON WALL 7222 (4 lines)
Factory: Concordia Works, London, E.14.

MANUFACTURERS OF
Scientifically developed and controlled Foundry Products

Prompt deliveries from stocks in
GLASGOW · MANCHESTER · SHEFFIELD · BIRMINGHAM & LONDON

Book Review

Creep of Engineering Materials, by Iain Finnie and William R. Heller. Published by McGraw Hill Publishing Company, Limited, 95, Farringdon Street, London, E.C.4; price 89s.

The authors of this excellent book have both been teachers in educational institutions in the USA and are now with the Shell Development Company. They point out that "Metallurgical design against creep was a general reality" soon after oil-cracking equipment was developed and they complain "that theoretical understanding of alloying effects and plastic flow in metals has still not caught up with practical advances." The one is an "engineer" and the other a physicist, but chapter 5 on the "Creep Behaviour of Specific Metals" shows that the metallurgical content of the book is good.

The properties of various steels are outlined, and "super" alloys, and alloys with aluminium, magnesium, copper, titanium and zirconium bases are reviewed. The influence of point defects in crystal lattices is appreciated throughout, and especially in chapter 4, and the effects of solute atoms and precipitating phases are considered. Chapter 3 deals with non-metallic materials and there are studies of the creep of ice. There is very little about casting, though in chapter 11 on "Specific Applications" reference is made to those alloys which can be precision-cast. The same chapter deals with turbines, missiles and creep effects in nuclear reactors.

The main portion of the work is a realistic treatment of stress design in relation to creep problems, and it is an excellent detailed book for the engineer. One example is the behaviour of cold expanded tubes in a tube plate, and thick-walled tubes and cylinders are considered. Fatigue stressing combined with creep is not avoided.

A full list of references is given at the end of each chapter. The authors have apparently decided to omit from the index—though they appear in the text—the names of well known alloys. One cannot turn up the properties of Nimonic, for instance, though some data will be found on pp. 243 and 296. It is also not clear on what basis the final author index has been compiled, for the Hatfield (misspelt Hadfield) time-yield test comes only in the subject index, but the name of Pfeil is not listed.

HUGH O'NEILL.

Publications Received

Annual Report, 1958. Published by the *Centre Technique des Industries de la Fonderie,* 12 Avenue Raphael, Paris 16.

The *Centre Technique des Industries de la Fonderie* was a "war baby." During the German occupation of France, the patriotic and enlightened section of the community used the period for planning for the future. (*Inter alia,* these years were used for redesigning French rolling stock and general modernization of the railway system.) It was Mr. le Thomas, director of the *Centre* both before and since its official creation in 1942, who envisaged a national technical service to the French foundry industry, something on the lines of the much older British Cast Iron Research Association. The 114-page report, just issued, is a testimony to the success which has been achieved.

The *Centre* now employs 334 people of whom 130 are on the staff, all being properly qualified in their professions, and operating from either Paris or one or other of the nine regional laboratories. In 1958, the pressure on the services of these laboratories was not so marked as, say, in 1953, which fact the present reviewer interprets as meaning that the creation of so many data lessens the need for adding to them.

A very useful review is given in the Report of recent researches carried out by the *Centre* and in every case reference is made to publications where the subject is dealt with *in extenso*. The Report makes very interesting reading and the service must be invaluable to the French foundry industry.

Your Crucible. Issued by the Morgan Crucible Company, Limited, Battersea Church Road, London, S.W.11.

The reviewer has a high regard for the publicity matter issued by the Morgan Crucible Company, Limited, but the excellent material contained in this six-page folder should, in his opinion, have been issued either in the form of a small pocket-size booklet or as a wall chart. With the format used, a buyer might easily be forgiven if he mistook the leaflet for sales literature and scribbled on it "file," whereas it is meant for study by those actually operating furnaces. In fact, it is a very sensible guide for the practical man on the care and use of crucibles; presented in another form it would have a better chance of reaching him.

International Illustrated Dictionary (1958 edition). Compiled and produced by the Mechanical Handling Engineers' Association, Association of Crane Makers, Aerial Ropeways Association and Association of Lifting Tackle Makers. (*Gratis* to approved applicants.)

This little book carries about 140 pictures of mechanical-handling equipment and component parts, and says what they are in English, French, German, Italian, Spanish, Swedish and Yugoslavian. Like all other dictionaries, its major use is for those familiar with the subjects covered, and the pictures accompanying the translations pin-point this aspect. Thus, in one case a receiver is illustrated, but except for this particular example, the translations given would be ridiculous. As a specialized dictionary it merits the reviewer's sincere recommendation.

Technical Bulletin, No. TB/RES/134/1, issued by the Shell Chemical Company, Limited, Marlborough House, 15/17, Great Marlborough Street, London, W.1.

In this *Bulletin* is covered very fully the foundry applications of Epikote resins. Stressed is the use of this material for foundry patterns, patternplates and coreboxes. Lightness, smoothness, abrasion resistance and—to coin a word—"repairability" are the outstanding characteristics claimed for patterns made from such a resin basis. As a number of additional materials are used in the preparation of such patterns, a concise directory is given as to the source of supply, and this is extremely useful. The bulk of the *Bulletin* is given over to practical instructions, which are clearly set out and easy to follow. This is an excellent contribution to trade literature.

Research for Industry 1958. Published for the Department of Scientific and Industrial Research by Her Majesty's Stationery Office, Kingsway, London, W.C.2; price 7s. 6d. net.

This is not the report in which to find detailed descriptions of the work of the research associations connected with the foundry industry. For those, one must have resort to the annual reports of the various bodies. This publication briefly covers the activities of all the numerous research associations (from those dealing with glue to motor cars), and will interest those people who like to keep abreast with research in general.

New Catalogues

Iron Castings. Newcast Foundries, Limited, Silverdale, Newcastle-under-Lyme, Staffs, possess a good sense of publicity. (They are amongst the handful of ironfounders who display posters at the railway stations.) Using a loose-leaf system of presentation, this new catalogue issued by the company deserves commendation on several grounds. There is, for instance, a map for the motorist, showing the location of the foundry and the offer of a car to the works from Stoke station for those arriving by train. Then again, the opening paragraph exhorts the customer to supply the best pattern possible for the making of a given type of casting and then the name of a master patternmaking firm in which the firm has confidence is given. This does make for initial co-operation and to continue this a coloured illustration of a pattern for a machine-tool component is included. The next point made is that a preference is shown for the delivery of a casting protected from rust by a primer. Photomicrographs are printed on white paper and the magnifications are quoted. Then comes a section on stress-relief annealing, followed by illustrations published by courtesy of a customer, of a number of machines for which Newcast has supplied the casting. It is not an extravagantly produced catalogue, but in every way fulfils the needs of the buyer in search of a source of supply of iron castings, and this is what modern trade publicity should do.

Cupola Dust-collectors. It is pleasing to see that in publication No. 79, W. C. Holmes & Company, Limited, Turnbridge, Huddersfield, have discarded the old-fashioned name of "spark arrestors," for truly something more is needed to-day, and the term cupola dust-collector is a more correct appellation. The firm's method, well described and illustrated in the brochure, involves the use of baffles, and a water spray. The amount of water lost is 10 per cent. of a range demanding 75 gall. per min. for a 2-ft. 8-in. cupola to 325 galls. for one of 9-ft. shell diameter. The system is known as the Holmes-Schneible type S.W. collector and the description in the catalogue details the various refinements that have been incorporated in the design.

Vibratory Conveyors. Vimec Equipment, Limited, Warrington, in a 12-page catalogue describe and illustrate quite a variety of vibratory conveyors, one of which is a spiral elevator for cooling whilst lifting material to a higher position. The reviewer has seen one such plant handling shell-moulding sand. A second is a screen mesh conveyor for separating either castings or sprues or tramp metal from the moulding sand. A quotation from the catalogue reads "The vibratory action of the conveyor frees the sand from the castings and suitable section of perforated deck enables the sand and castings to be segregated. Many of these foundry installations contain conveyors of considerable size and range. For instance, units 30-in. wide and 100-ft. long with troughs constructed of ¼-in. mild-steel plate are quite common."

Epocast in the Foundry. Issued as *Technical Bulletin* 7 by Furane Plastics Inc., 4516 Brazil Street, Los Angeles 30, California, USA.

The firm issuing this *Bulletin* is amongst the most meticulous in sending their trade literature to the JOURNAL, and this particular *Bulletin* warrants notice because of the clear illustrated descriptions it gives of the practical uses of Epocast resins in foundry practice. At the end of the booklet there is a two-page appendix, which details trial kits for making boxes for core-blowing machines; for ordinary coreboxes; for making matchplates and for making equipment to be used under hot sand. These four subjects are dealt with in the *Bulletin*, which is so interesting that readers are recommended to write to Los Angeles for a copy.

Mains-frequency Induction Furnaces. Information folder No. 6609049E has been received from ASEA, Vasteras, Sweden, through the British representatives of the company, Fuller Electric, Limited, Fulbourne Road, London, E.17. The folder covers three types of low-frequency electric-melting furnaces, the first of which is a holding furnace of the stationary channel-type. The second is a two-chamber furnace designed for melting and holding copper and aluminium alloys, and the third type is a tilting furnace. After a general description of each furnace, capacities, power-consumption, etc., are detailed for aluminium, brass and copper. Line drawings and illustrations of the plants are included in the brochure.

Factory Ventilation. Greenwood and Airvac Ventilation Company, Limited, Beacon House, Kingsway, London, W.C.2, have issued a four-page illustrated folder to describe and illustrate nine systems of natural and powered ventilation the company has supplied to a like number of totally different types of enterprises. The range dealt with is indeed interesting.

House Organ

Bulletin Mensuel d'Information, No. 100. Issued by the *Association Technique de Fonderie*, 2 rue de Bassano, Paris 8.

This is a special issue designed to commemorate the hundredth issue of the *Association's* monthly *Bulletin*. It opens with an introduction by the president, Mr. J. Lainé, and then prints the portraits of all the presidents since 1911. (With the exception of the first, Mr. Emile Barthe, the reviewer recognizes personally the other eighteen.) Then follows an article on the creation of the *Association* by Mr. Camille Didier, the director of *L'Usine Nouvelle*, and at that time Editor of the *Fonderie Nouvelle*. His campaign in the latter magazine resulted in a meeting held at Nancy, after which the *Association Technique de Fonderie* was launched, and registered in the *Journal Officiel* in January 1911. Mr. Didier was the first secretary and Mr. Ronceray the first treasurer.

Mr. J. Léonard of Belgium, one of the five foreign vice-presidents who have served since the inception of the *Association*, has contributed to the *Bulletin* a very interesting article which stresses the international authority and activities of the *Association*. He quotes a table, issued in 1957, detailing the foreign membership of the *Association*, this the reviewer considers to be in error as there has always been a handful of British members and in this table none is mentioned. Finally, Mr. A. Brizon outlines the history and development of the International Committee of Foundry Technical Associations. The caption beneath the picture showing three vice-presidents at the 1934 Philadelphia conference is also wrong, it should read (left to right) Mr. Léonard, Mr. Brizon and Mr. Vanzetti. In general, the pictures are not too well reproduced.

GEO. ANGUS & COMPANY, LIMITED—Mr. J. M. S. Coates has been appointed a director.

Pig-iron and Steel Production

Statistical Summary of April Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table 1 summarizes activities during recent months. Table 2 gives production of steel ingots and castings in April. Table 3, weekly average production of finished steel in March. Table 4 gives the production of pig-iron and ferro-alloys in April, and furnaces in blast. (All figures are weekly averages in thousands of tons.)

TABLE 1.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	B.o.T. Price Index, 1938 = 100.			Iron-ore output.	Imported ore used.	Coke sent to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	Iron and steel.	Coal.	Basic materials excl. fuel[1]						Imports.[2]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[3]
1957	328	488	537	325	303	270	275	220	14	417	322	1,444
1958	343	503	478	276	262	227	245	196	9	369	284	1,542
1959—Feb. ..	342	506	473	277	214	199	222	190	5	347	276	1,485
Mar.[4]	342	505	473	276	217	195	221	195	4	363	266	1,479
Apl. ..	342	506	477	299	219	201	231	211	5	387	—	1,459

TABLE 2.—*Average Weekly Production of Steel Ingots and Castings in April*, 1959.

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derbys, Leics., Notts., Northants and Essex ..	—	3.6	14.9 (basic)	1.9	0.1	19.2	1.3	20.5
Lancs. (excl. N.W. Coast) Denbighs, Flints. and Ches., ...	1.0	33.3	—	4.6	0.3	38.0	1.2	39.2
Yorks. (excl. N.E. Coast and Sheffield)								
Lincs.	—	49.7	—	—	—	49.6	0.1	49.7
North-East Coast	0.5	61.4	—	1.2	0.3	61.9	1.5	63.4
Scotland	1.0	32.2	—	2.1	0.1	33.7	1.7	35.4
Staffs., Shrops., Worcs. and Warwicks. ..	—	16.8	—	3.9	0.8	19.6	1.9	21.5
S. Wales and Monmouthshire	1.8	90.8	7.2 (basic)	0.8	0.1	100.3	0.4	100.7
Sheffield (incl. small tonnage in Manchester) ..	7.1	33.5	—	11.3	0.3	50.6	1.6	52.2
North-West Coast	0.1	0.9	3.2 (acid)	0.4	0.1	4.5	0.2	4.7
Total	11.5	322.2	25.3	26.2	2.1	377.4	9.9	387.3
March, 1959[4]	11.4	303.3	23.6	22.5	1.9	353.4	9.3	362.7
April, 1958[4]	15.3	346.2	21.6	22.2	2.5	396.8	11.0	407.8

TABLE 3.—*Deliveries of Non-alloy and Alloy Finished Steel.*

Product.	1957.	1958.	1958.	1959.	
			Mar.	Feb.	Mar.[5]
Non-alloy steel:					
Ingots, blooms, billets and slabs[5]	5.0	4.6	5.2	4.3	4.1
Heavy rails ..	11.2	10.2	11.4	8.2	7.3
Sleepers	1.3	1.2	0.7	1.0	0.7
Fishplates and sole-plates	0.8	0.7	1.0	0.5	0.3
Plates: (i) ⅜ in. thick and over ..	34.0	29.6	35.7	27.4	25.1
(ii) Under ⅜ in. ..	20.3	17.7	20.2	18.0	17.2
Other heavy prod.	53.0	41.8	56.8	35.1	35.5
Ferro-concrete bars	8.9	7.6	8.2	6.6	7.9
Wire rods	23.3	21.5	22.7	22.3	21.1
Arches, etc. ..	11.0	8.6	10.4	8.6	8.7
Other light sections	38.7	29.1	33.0	30.4	28.5
Bright steel bars ..	7.0	6.2	7.1	7.0	6.3
Hot-rolled strip ..	23.1	22.6	25.0	27.2	26.7
Cold-rolled strip ..	7.1	7.0	8.5	7.7	7.0
Sheets, (i) Hot-rolled	13.0	10.6	12.1	10.4	10.8
(ii) Cold-reduced..	29.1	31.1	32.0	34.2	33.3
Tinplate:	18.8	18.7	17.3	21.2	18.9
Blackplate.. ..	1.0	0.8	1.0	0.8	0.7
Tubes up to 16 in..	22.1	19.0	2.1	18.7	18.4
Tube, pipe fittings	0.5	0.4	0.4	0.4	0.4
Tyres, wheels, axles	5.1	4.5	5.8	2.9	3.0
Forgings (excl. drop)	3.1	2.6	3.1	2.2	2.0
Steel castings ..	4.6	4.2	5.3†	3.7†	3.6†
Tool and magnet ..	0.3	0.2	0.3	0.2	0.2
Total	342.3	300.5	345.3	299.0	287.7
Alloy steel	17.8	16.1	20.9	17.3	17.0
Total deliveries from U.K. production[6]	360.1	316.6	366.2	316.3	304.7
Imported finished steel	9.6	7.1	10.9	4.5	6.3
	369.7	323.7	377.1	320.8	311.0
Deduct: Intra-industry conversion[7] ..	48.2	41.2	49.0	45.9	46.1
Total new deliveries	321.5	282.5	328.1	274.9	264.9

TABLE 4.—*Production of Pig-iron and Ferro-alloys*

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derbys., Leics., Notts., Northants and Essex	19	2.5	21.6	15.7	0.2	—	40.0
Lancs. (excl. N.W. Coast), Denbigh., Flints. and Cheshire ..	7	—	20.6	—	—	1.3	21.9
Yorks. (excl. N.E. Coast and Sheffield)							
Lincs.	8	—	41.6	—	—	—	41.6
North-East Coast	17	2.8	40.0	—	—	0.7	43.5
Scotland	6	0.6	14.2	0.7	—	—	15.5
Staffs., Shrops., Worcs., Warwicks	4	—	5.9	0.9	—	—	6.8
S. Wales and Monmouthshire	9	2.9	41.9	1.0	—	—	45.8
Sheffield ..	2	—	3.5	—	—	—	3.5
North-West Coast	7	11.6	—	0.2	—	0.9	12.7
Total ..	79	20.4	189.3	18.5	0.2	2.9	231.3
March, 1959[4] ..	80	17.6	181.8	18.5	0.3	3.0	221.2
April, 1958[4] ..	91	26.1	202.5	24.1	0.6	3.6	256.9

[1] Used in non-food manufacturing industries.
[2] Weekly average of calendar month.
[3] Stocks, mainly ingots and semi-finished, at the end of the year and months shown.
[4] Five weeks, all tables.
[5] Other than for conversion into any other form of finished steel listed.
[6] Includes finished steel produced in the UK from imported ingots and semi-finished steel.
Material for conversion into other products also listed in this table.